Report

National Brucellosis Technical Commission

Appendix A

The Public Health Aspects of Brucellosis.

August 28, 1978

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THE PUBLIC HEALTH ASPECTS OF BRUCELLOSIS

I. BRUCELLOSIS IN HUMAN BEINGS

1. THE ROLE OF PEOPLE IN THE SPREAD OF BRUCELLOSIS

Brucellosis (undulant fever) spreads to people from animals. Spread from person to person rarely if ever occurs. By contrast, the infection in animals is contagious for infected animals readily infect other animals, and their illness may become chronic with shedding of the organisms into the environment, often for many years. The role of human beings is still an important one, for by domesticating animals and herding them together, moving them from one area to another, people provide conditions which, though ages old, are quite unnatural and greatly increase the ease by which Brucella survive both inside and outside the hosts (18).

2. ACQUISITION OF BRUCELLOSIS

The disease in people is contracted from infected animals or from their products; it is food borne by raw meat, raw milk and dairy products, (i.e., butter, ice cream, cheese, etc.). For some people the disease is an occupational hazard, particularly for farmers, livestock workers, dairymen, veterinarians, meat inspectors, packing plant workers, butchers and others who work with contaminated byproducts of packing plants.

People may acquire infection through various portals of entry. There may be contamination of abrasions or cuts of skin, inhalation of aerosols of Brucella through the nose and lung, ingestion by mouth or contamination of the eyes. Unwashed hands, contaminated with the bacteria from infected raw meat or milk products, may convey the infecting Brucella to food which is then eaten, or to abrasions, cuts of the skin and to the eyes.

3. PATHOPHYSIOLOGY

The Brucella organisms invade mucous membranes, enter the lymphatic system, localize in regional lymph nodes and subsequently invade the blood stream and disseminate throughout the body. Secondary localization occurs particularly in organs and tissues, which possess abundant reticuloendothelial cells, spleen, liver, bone marrow, lymph nodes and kidneys. The Brucella localize in the cytoplasm of the phagocytic mononuclear cells of tissues with resultant formation of granulomatous lesions. Necrosis of tissue in slight or absent, but abscess formation and caseation may occur. The host response is one of phagocytosis by mononuclear and polymorphonuclear cells and the production of both humoral and cellular immunity. A state of hypersensitivity may be a prominent feature in human beings (63,64).

4. MANIFESTATIONS

Infected people develop malaise, fatigue, fever, chills, sweats and weakness as common manifestations. Most patients also complain of body aches, headache, and anorexia. There is usually weight loss which ranges from 5 to 50 lbs. A cough may be present in about one fifth of patients. Those who develop arthralgia, demonstrate monarticular involvement in approximately 50% of cases. Other manifestations include nervousness, backache, insomnia, mental depression, pain in back of the neck, abdominal pain, constipation, diarrhea, visual disturbances, nausea, vomiting, neuritic pain, testicular swelling and pain, dysuria, dizziness and tinnitus. The signs include fever, splenomegaly and lymphadenopathy, as most frequent physical abnormalities, however, some patients demonstrate abdominal tenderness, hepatomegaly, cardiac abnormalities, neurological changes, tenderness over the spine, skin lesions, funduscopic changes, orchitis, jaundice and tenderness of joints (7,27, 63).

5. IMMUNITY AND RESISTANCE

At the present time there is no effective or safe method of immunizing man. There may be some degree of immunity following an attack of brucellosis but second attacks occur (7,63). Subsequent attacks may be mild, however, hypersensitivity may exist and result in severe illness (21,64).

Work is in progress in Iowa and at the CDC in a cooperative study to develop a vaccine which could be used safely for the prevention of brucellosis in workers who have high degrees of exposure to infection by reason of their occupation. Evidence to date indicates that the vaccine, a killed strain of Brucella suis is effective in prevention of the disease in guinea pigs and primates against challenge of Brucella suis and Brucella abortus. Plans are now being made for a clinical trial in people (22).

6. PROGNOSIS IN BRUCELLOSIS

The illness may vary in severity from a mild episode which persists for a few days to a fatal result. Spink reports a mortality rate of 2% of treated cases (63). Records from the Minnesota Department of Health reveal that of the 4,386 cases reported from 1927 through 1956 that 30 people or 0.68% died of the disease (35). Of 313 people reported with brucellosis in Texas from 1960 to 1975, 6 or approximately 2% died (45).

7. COMPLICATIONS

Although most patients, who are diagnosed as having brucellosis

and are treated for the disease, have an uneventful recovery complications may be severe. There may be a diffuse or localized encephalopathy with debilitating neuropsychiatric disorder (19), chronic arthritis, particularly spondylitis, osteomyelitis, bursitis (30,46,47), endocarditis (8), hepatitis (17), splenitis with hypersplenism and associated thrombocytopenic purpura and hemorrhage (81), infections of the genitourinary tract, orchitis, epididymitis, and pyelonephritis (23). Brucella pneumonia has been described (32) with pleural effusions and empyema (48). Visual disturbances are common manifestations and are due to involvement of the optic nerve and other structures of the eye (25, 56).

8. TREATMENT OF BRUCELLOSIS

Therapy with tetracycline for 3 weeks or with tetracycline for 3 weeks plus streptomycin for the first 2 weeks results in cure in approximately 80% of the cases (63). Chloramphenicol has been used successfully, but has had limited trials in therapy of human brucellosis because of disadvantages in its use (43,44,63). Trimethaprim and sulfamethaxazole in combination has produced remissions in acute brucellosis (33). The addition of sulfonamides to streptomycin therapy has been successful in some cases (55). A problem in the treatment of brucellosis is that relapse may occur (63).

9. CHRONIC BRUCELLOSIS

A patient is considered by Spink to have chronic brucellosis if the illness endures for longer than one year (63,65,66,68). A study of 30 such patients demonstrated definite evidence of localized disease in 12, with clinical and laboratory evidence of disease in 5. The remaining 13 people complained of ill health but without any objective evidence of active disease (63). These latter group of patients presents a problem of diagnosis and therapy. It is known that some physicians may tend to diagnose chronic brucellosis in patients with neurasthenia without objective evidence of the disease, because of the curious evolution of a concept that brucellosis results in such a clinical state.

10. DEFINITIONS

In order to avoid confusion and misunderstanding in evaluating data for the diagnosis and treatment of patients, for the purpose of reporting cases of human brucellosis, and for determining the legitimacy of claims for workman's compensation, it is essential to have agreement on the criteria for defining human brucellosis. The following definitions have been developed and are used by the CDC (12).

(1) Confirmed case - a patient with a clinical specimen positive

for Brucella, or a patient with clinical symptoms compatible with brucellosis such as any combination of fever, sweats, chills, undue fatigue, anorexia, weight loss, arthralgia, lymphadenopathy, and splenomegally, and a 4 fold or greater change in Brucella agglutination titer between acute and convalescent serum specimens obtained 2 or more weeks apart and studied at the same laboratory.

(2) Presumptive case - a patient with clinical symptoms compatible with brucellosis having either a Brucella agglutination titer positive at a 1:160 or higher dilution on a single serum specimen obtained following the onset of symptoms or a stable Brucella agglutination titer positive at a 1:160 or higher dilution in serum specimens obtained following the onset of symptoms.

(3) Recrudescent case - a patient who meets the criteria of a confirmed or presumptive case both at the time of his present illness and at any time within 3 previous years.

(4) Reinfected case - (not listed by CDC) - a patient with the same criteria as that of a confirmed or presumptive but occuring more than 3 years following the previous infection.

(5) Adequate therapy - antimicrobial therapy meeting the minimum recommended dosage and duration: Tetracyclines (tetracycline, chlortetracycline, oxytetracycline, or equivalent analogue) 2 gm per day orally for 3 weeks, with or without streptomycin (only if seriously ill) 1 gm per day I.M. for 2 weeks. Sulfonamides may optionally be used in addition to tetracycline and streptomycin.

(6) Inadequate therapy - therapy with tetracycline or streptomycin at less than the recommended dosage or duration.

(7) Other therapy - therapy with antimicrobial agents having unknown efficiency such as penicillin, erythromycin and ampicillin.

II. REPORTS OF CASES OF HUMAN BRUCELLOSIS

1. REPORTING AND ACCURACY OF REPORTS

Brucellosis is a reportable disease in every state of the United States except Nevada (53). Every physician is required in the other states to report to the department of health of the state of any occurrence of the disease in people. The reports are transmitted to the Center for Disease Control (CDC) in Atlanta, Georgia, where they are tabulated and reported annually (24).

The total number of cases of human brucellosis in the United States is unknown, because all cases are not reported. The infected person may not seek medical attention. The physician may fail to

recognize the disease as brucellosis. Infections that are recognized may not be reported. Attempts to estimate the actual number of cases of disease in people have been made by the Brucella Technical Commission by questioning every state public health epidemiologist in the U.S. To the question "What percentage of actual cases of human brucellosis do you estimate is reported by physicians, hospitals, etc., in your state?" the following responses were obtained:

"Many physicians do not report."

"No cases have been reported. It is unlikely that none occurred."

"Unknown"

"Under-reported."

"No idea."

"± 100% - all tests are done in state laboratory."

"Less than 10%."

"10%"

"20 - 30%"

"30%"

"50%"

"50 - 75"

"70%"

"80%"

"90%"

"Less than 100%"

"100%" (No cases were reported)

Dr. S. J. Lerro, Director, Division of Epidemiologic Surveillance, Texas Department of Health Resources who reported an "Epidemiologic Overview of Human Brucellosis in Texas 1960-1969 and 1970-1975" reported to the Commission that about 20% of human cases are reported" (45).

A report from California (70) estimated the number of reported cases to be about one tenth of the cases actually occurring. Human infections reported in the United States in 1950 were 3,510. However,

the undiagnosed and unreported cases were estimated (on the basis of detailed examination of certain areas) to be between 40,000 and 100,000 for the year 1950.

A study in Utah (73) in 1949 concluded that there were 26 unreported cases for every one reported, a reporting rate of 3.7%.

As stated above Nevada does not require cases of brucellosis in humans to be reported. A list of reportable diseases is prepared by the Nevada State Board of Health each year (NRS 439.220) and brucellosis is not included. Nevada is the only state in the United States that has made no reports of brucellosis to CDC since 1966, as seen in Table 1 (12). There have been no reports of human brucellosis to the State Department of Health of Nevada since 1962, as reported to the National Brucellosis Technical Commission (53).

It is probable that all cases of human brucellosis are not reported to the public health officials. Attempts have been made to determine the incidence of previous infections in various groups of people by interview, by testing for agglutinating antibodies in blood serum, and by skin testing using a protein derivative from Brucella. Angle et al. (2) reported in 1938 that 9% of 7,122 school children in Kansas City had positive skin tests. Spink et al. (66) found 104 (19.5%) of 533 people who were attending the outpatient department at the University of Minnesota Hospital in 1945 to have positive skin tests and 10% of children reacted positively (63). In 1948 302 or 18.5% of 1,627 blood donors at the University of Minnesota Hospital were found to possess Brucella agglutinins, and 27 had titers of 1-160 or higher (67). Magoffin et al. (49) reported that during 1947, when 378 cases of brucellosis were reported in Minnesota, Brucella agglutinins were found to be present in a titer of 1:40 or higher in 1,201 human sera submitted for this examination to the laboratories of the Minnesota Department of Health.

A survey of 25,294 sera for Brucella agglutinins was reported by Stoenner et al. (73) from the Utah V.D. Laboratory in 1949 and 577 (2.28%) were found to be positive for Brucella agglutinins. They calculated that there were 26 unreported infections per year to one reported case.

Serological surveys of the general population failed to detect evidence of infection as was attempted by Schnurrenberger et al. (60), who found sera of 846 people of rural residence in Illinois to be nonreactive in 1965. Serological surveys of occupational groups, with known exposure to animals, have revealed the presence of antibody titer indicative of of past infection with brucellosis. Hendricks et al. (37) found 31 asymptomatic employees of a packing plant in Iowa to have antibody titers ranging from 1:320 to 1:40,960 during a period in 1959-1960 when outbreaks of brucellosis were occurring. Seven percent of 1,153 abattoir workers in California had serological evidence of pre-

vious infection in 1971 (71). Schnurrenberger et al. (61) also reported that 224 (17%) of 1,315 Illinois veterinarians and 71 (12.9%) of 783 employees of an Illinois abattoir had evidence of previous infection with brucellosis in 1966.

The efficiency of reporting appears to vary with different environments. Review of reporting from some states reveals that most cases of human brucellosis are reported by a small group of physicians, particularly those working with employees of packing plants. This appears to be evident in Virginia, Iowa and California. It is concluded that there is a need to emphasize to physicians the importance of diagnosis and reporting of cases of human brucellosis.

2. RECOGNITION OF BRUCELLOSIS BY PHYSICIANS

The manifestations of the disease in people are not specific for brucellosis, but may be characterisitic of other diseases. The illness may vary in its manifestations from a low-grade fever, which is ill defined, to a severe febrile state with chills, sweating and protration. These manifestations are similar to those of other diseases such as the "flu" or a "Virus disease." Brucellosis may simulate infectious mononucleosis, typhoid fever, malaria, viral hepatitis, amoebiasis, tuberculosis, lymphoma and other diseases which must be considered under the category of "fevers of unknown cause" until the diagnosis is made.

If the disease is to be reported to the public health officials, the physician first must recognize the possibility of brucellosis and then diagnose the illness as brucellosis by appropriate laboratory tests. The possibility of brucellosis as the cause of the illness is indicated by the typical manifestations of the illness, the occupation of the patient or the history of ingestion or handling of raw meat or raw dairy products, the recognition that lymphadenopathy and splenomegaly may be present or absent in brucellosis, and that a normal or reduced total leukocyte count with lymphocytosis is usuallly present (7,63).

It is at this point in the search for diagnosis that the physician should consider brucellosis. The next step is to request a rapid slide agglutination test, which provides information rapidly, acute and convalescent specimens of sera for the tube agglutintion test, and specimens of blood for culture of Brucella should be obtained before initiation of any antibiotic therapy. The tube agglutination test supplemented by the complement fixation test on the convalescent serum is the most dependable serologic diagnostic procedure, but requires longer time than the rapid slide agglutination test. Reddin et al. (57) has observed a correlation between Ig. G. Brucella agglutinins and recent infection, and Anderson et al (1) has observed that the complement fixation test is a better indicator of active or recent infection than the standard tube and centrifugation agglutination tests. Isolation of Brucella from blood or tissues establishes the diagnosis as brucellosis.

Blood cultures are reported to be positive in approximately 50% of acute cases when performed by competent methods (63).

3. TECHNICAL ASPECTS OF REPORTED CASES OF HUMAN BRUCELLOSIS

a. SEROLOGIC FEATURES

The CDC reports that the Brucella agglutination test is the most commonly used test in the diagnosis of human brucellosis (11,12). During the two years 1975-1976 there were 599 reported cases; serologic data were available on 555 (92.3%). Specimens of acute and convalescent serum were tested in 335 (60.4%) of the 55 cases. Diagnosis was based on the testing of a single specimen of serum in 220 (39.6%). The diagnosis for nine (1.6%) of the 55 cases were questionable because the reported titers were less than 1:160 and isolation of Brucella was not attempted.

A recent report in 1977 by Taylor et al. (75) of a survey of over 900 laboratories revealed that 393 responded to the study of their proficiency in the detection of Brucella antibody by the slide or tube test. The largest source of variation in the bacterial agglutination tests was the antigen, which emphasizes the need to develop standard antigens. Re-evaluation of the reference antigen recommended for use in the standard Brucella agglutination test revealed that it should be diluted 1-50 instead of 1-100 to conform to the U.S. Department of Agriculture standard. This change appeared to increase the reproducibility of results by decreasing prozone and other erratic reactions while producing sharper end points. Manufacturers have been notified of this change by the CDC and have been encouraged to use the same Brucella strain now used by the National Animal Disease Laboratory. A survey of public health laboratories in the 50 states, the District of Columbia, and three possessions of the United States by the National Brucellosis Technical Commission (53) in 1977 showed that 33 use commercial antigens, seven prepare their own and fourteen failed to respond.

b. MICROBIOLOGIC FEATURES

For the two years 1975-1976 reports of 580 cases of human brucellosis were received by the CDC. Of these, clinical specimens from 222 were cultured for Brucella. Specimens from 130 (58.5%) of the 222 were positive for Brucella species. Table 2 reveals the results of the cultures and the relative frequency of the species for the period 1975-1976 (11,12).

Brucella abortus was isolated from cultures in 52 human cases. Sources were considered to be from cattle in 27, from cattle or domestic swine in 17, from domestic swine in 1, from unspecified farm animals in 1, from raw dairy products of Mexico in 3, from 1 laboratory accident

and 2 were from unknown sources.

Brucella suis was isolated from cultures in 53 human cases. Sources were considered to be domestic swine in 37, cattle or domestic swine in 5, cattle in 2, feral swine in 2, unspecified farm animals in 1, caribou in 1, from 1 laboratory accident, and 4 were from unknown sources.

Brucella melitensis was isolated from cultures of 10 human cases. Six of these were believed to be associated with ingestion of foreign dairy products from Mexico (4 cases) and Greece (2 cases), 2 from laboratory accidents and 1 was from an unknown source.

Brucella canis was isolated once from a human case in 1976, which brings the total number of Brucella canis infections reported, since the first case was reported in 1967, to 17. This single infection by Brucella canis was reported in a woman whose dog had aborted during the month prior to onset of her illness.

Brucella species were isolated but not specified from 14 human cases. The sources were believed to be from swine in 8, from cattle in 1, cattle or swine in 2, and Italian dairy product in 1, and the source was unknown in 1 case.

4. NUMBER OF REPORTED CASES OF HUMAN BRUCELLOSIS IN THE UNITED STATES

The number of reported cases of the disease in humans was 6,321 in 1947 (4.4 cases per 100,000 population), the year that the methods and rules designed to eradicate the disease were made uniform. This was 13 years after a nationwide voluntary program to eradicate brucellosis was begun under the direction of the U.S.D.A. in cooperation with the states. There was a steady decline in the number of reported cases over the years to a figure of 175 (0.083 per 100,000 population) reported cases in 1973. This represents a 36th decrease of reported cases in 26 years.

Since 1973 there has been an increase in the reported cases of human disease. Reported cases numbered 246 in 1974, 328 in 1975 and 282 in 1976. The number of reported cases for each state for 1976 and for the years 1966-1975 are seen in Table 1 (12). The distribution of reported cases for the years 1947 through 1976 are seen in Table 3 and Figure 1. As will be discussed later, the increase in recorded cases of human brucellosis after 1973 was coincident with an increase in reported brucellosis in cattle in the United States.

5. SOURCES OF INFECTION OF REPORTED CASES OF HUMAN BRUCELLOSIS

Swine have consistently been the most common source of human bru-

cellosis in the period 1965-1974, however, for the years 1975 and 1976 for the first time since 1959, cattle have replaced swine as the most common source of this infection (11,12). Table 4 lists the most probable sources of brucellosis for the year 1975 and reveals that cattle were the source in 33.7% and swine in 30.5% (11). Unspecified farm animals accounted for 1.9% of infections. Wild animals (deer, 1 case; caribou, 1 case; and feral swine, 4 cases) accounted for 1.9%. Eight cases (2.6%) were reported from domestic unpasteurized dairy products. Sixteen cases (5.2%) were attributed to foreign dairy products including raw milk or cheese from Mexico (10 cases), Greece (2 cases), Italy (2 cases), India (1 case), and Thailand (1 case). There were no cases of infection with Brucella canis reported from dogs in 1975, however, one infection from this source was reported in 1976.

Similar data for the years 1970-1975 is available in a report from Texas (44), which has the largest number of infected herds of cattle in the nation. Table 5 lists data taken from this report which reveals that of 132 cases of human infections reported, 63 (47.7%) had cattle as the source. In addition, unpasteurized dairy products accounted for 41 cases, or 31.1%. It is of interest that of the latter group of people, 38 had consumed fresh cheese from Mexico, 3 ingested raw milk in Texas, 2 drank raw milk in Mexico and 1 ate ice cream in Mexico. An infected welder repaired cattle trailers.

6. ASSOCIATION OF OCCUPATIONS WITH BRUCELLOSIS

Brucellosis is an occupational hazard for people who come into contact with infected animals or their byproducts. Tables 6, 7, and 8 present analysis in regard to occupations of the people with brucellosis reported to CDC for the period 1970-1975 for each state that reported human infections. These data emphasize exposure to cattle, their byproducts in packing plants, and unpasteurized dairy products as the most important sources of brucellosis in humans, and that there were increasing numbers of reported infections in humans from these sources during this period. Table 4 reveals that 60% of the 309 cases, for which reports were received by CDC in 1975, were in individuals working in the meat processing industry. Abattoir workers constitute the largest group of reported cases. The second largest group consists of workers in the livestock industry (employees, producers, and veterinarians) who constituted 19.1% of the reported cases. Figures 2 and 3 show graphically the trends of acquisition of brucellosis by occupational groups during the period 1965-1974. It is evident that workers in the livestock industry are suffering increasing incidence of infection in recent years. There is increasing awareness of the incidence of brucellosis in occupational groups as indicated by the reports from Iowa, Virginia and California.

The incidence of brucellosis in the general population is presented in Table 8. This data indicates that the number of cases of

brucellosis in Table 8. This data indicates that the number of cases of brucellosis in the general population has remained at a fairly constant level during the last decade.

III. BRUCELLOSIS IN PACKING HOUSE EMPLOYEES

1. THE ENVIRONMENT FOR INFECTION

The problem in packing plants is a unique one for the employees are placed in a situation, because of their employment, of exposure to a disease for which there is no adequate means of detection, and methods of prevention are not satisfactory. At the present time there is no successful program to protect packing house employees from exposure to brucellosis from animals presented for slaughter.

Animals which are found to be reactors with Brucella agglutinins are sent to the packing plants for slaughter. Sadler (58) reports that inasmuch as there are no distinguishing macroscopic lesions in Brucella infected cattle, none are condemned post mortem for brucellosis, and all find their way into retail channels in one form or another unless condemned for other reasons. These reactor animals pose a hazard to the public health if the meat and byproducts carry viable Brucella microorganisms.

Attempts have been made to isolate Brucella abortus from cattle showing positive agglutination titers. Doyle (20) isolated Brucella abortus from various tissues in 26 of 32 naturally infected cattle with positive agglutination titers. In 17 cows isolations were successful from tissues other than the udder and supramammary lymph nodes, and demonstrated that Brucella abortus may be widely distributed in the bodies of naturally infected cows. As the animals were brought at random it appears reasonable to regard the distribution of the organisms in them as a fairly true picture of its distribution in carrier cows in general. McCullogh et al (50) isolated Brucella abortus from 42 of 100 naturally infected reactor cattle routinely slaughtered. They stated, "The isolation of Brucella abortus from numerous sites in a significant number of the animals examined emphasizes the potential exposure to brucellosis encountered by personnel engaged in processing the carcasses of Bangs reactor cattle."

Visible distinctive lesions of brucellosis in swine are found only in the spleen and lumbar region of the vertebra, according to Sadler (58) who reported that of the 3 3/4 million Brucella agglutinin positive swine killed in 1955, only 10 were condemned for brucellosis. McCullough et al. (51) removed one submaxillary lymph node from each of 5,000 hogs over a period of 5 months and isolated Brucella abortus from 10, Brucella melitensis from 11 and Brucella suis from 14. The 35 isolations represented an incidence of 0.7%, McNutt (52) isolated Brucella from 12 of 34 agglutinin positive swine. Huddleson et al. (38) reported

that tissues from 41 of 308 agglutinin positive swine yielded cultures of Brucella suis. Hutchings et al. (39) isolated Brucella melitensis from various tissues on each of 11 agglutinin positive swine. Johnson and Huddleson isolated Brucella suis from the meat of 15 of 25 reactor swine and none from 29 agglutinin negative swine. It can be concluded that reactor cattle and swine may be infected, and that the meat, blood and lymph, which contain Brucella microorganisms, may serve as the source of brucellosis in people, who have contact and become infected.

Direct contact with infected animals or their tissues, with the microorganisms entering the human host through abrasions and cuts of the skin is recognized as the most common method of transmission of brucellosis from animals to man (29,63,67). There is evidence suggesting that a variety of factors, including aerosols, may be responsible for transmission to workers from animals being processed in slaughtering establishments (6,7,29,34,37,40,61,63,71). The isolation of Brucella from the air of a packing plant has been accomplished (34).

Reports of human infection indicate that the packing plant is a significant factor in spread of Brucella organisms from animals to people. Hardy et al. (29) in 1930 reported that 10% of 375 patients with brucellosis worked in packing plants. Harris (3) reported that of 700 people who developed brucellosis from 1942 to 1945, 16% were employees of packing plants. Spink (63) in reporting 244 cases of brucellosis between 1937 and 1954 found 134 or 54.8% to occur in this occupation. Over half of the cases of packing plant employees occurred in 1949 or thereafter. Some of the patients reported that they had no direct contact with animals or they byproducts.

An excellent description of the environment of a packing plant and opportunity for infection is provided by Hendricks et al. (37). They found that attack rates were related to the area of the plant rather to degrees of contact of employee with fresh animal tissues. Epidemiological findings indicated that airborne infection may have been a factor in the outbreak which resulted in 128 cases among 1,627 employees.

The percentage of infections of packing house employees has steadily increased over the years as shown in Table 9. In 1958, 28% of all cases of human brucellosis reported to CDC with complete case histories was in packing plant employees. This increased to a peak of 71% in 1969 (16). Spink (63) explained that the increasing percentage of infected packing plant employees was caused by the program of eradication which was resumed after World War II and decreased the number of infected cattle on farms. Farmers and dairy workers became less exposed. The slaughter of positive reactor cattle increased the exposure to people in packing plants. In addition, physicians learned to recognize the disease early in this occupational group.

As the human disease became increasingly associated with packing plants, there was a decrease in frequency of Brucella abortus, the organism most frequently associated with cattle, and in increase in

frequency of Brucella suis, the organism most frequently associated with hogs. In the series of infections among packing plant workers reported by Spink for the period 1937 to 1954, 81% were caused by Brucella abortus (63). After years of the state-federal cooperative brucellosis eradication program directed almost entirely at cattle, the CDC reported that during 1965-1971, 77% were Brucella suis. The animal reservoir changed as the prevalence of the disease decreased in cattle. From 1969 to 1976 more than half of the reported cases of brucellosis in the United States occurred in people associated with the meat processing industry. Of 2,189 reported human infections, 1,228 (56%) were abattoir associated infections, which had reduced to approximately 100 per year by 1973, increased to 185 in 1975.

2. REPORTS OF OUTBREAKS OF HUMAN BRUCELLOSIS

Buchanan et al. (7) reported infections of 160 people who worked at a single abattoir in Iowa from 1969 to 1970. Of the 900 randomly selected employees from whom a blood specimen was obtained during an epidemic in 1970, 55 asymptomatic persons with no previous history of brucellosis had immunological evidence of previous infection. They predicted that of 2,700 workers, 165 subclinical infections had occurred in addition to the 160 cases reported. There were no deaths. Of the 160 patients with manifestations of illness, 36 (22%) required hospitalization. Some patients were ill for more than 90 days, however, the mean duration of absence from work was between 41 and 49 days with a low rate of complications of 0.6% in comparison with a rate of 9% as reported by Spink (63). It is evident that infection of packing plant employees is recognized and treated earlier than non-abattoir patients. Physicians associated with packing plants are more alert to the problem of brucellosis than are physicians who are not associated with packing plants.

A report of an investigation (71) of the occupational problem of brucellosis in slaughter house employees in California in 1971 revealed that the sources of human brucellosis were primarily related to the slaughter of swine. Of the swine slaughtered in California at that time, 90% were animals imported from out of state, primarily Iowa, Nebraska, Missouri and Kansas. The testing of 10,781 specimens of swine blood, each specimen being collected from every twentieth animal of 207,914 imported market hogs during an eight week period, May 3 to June 25, 1971, revealed 21 (0.2%) (2 per 1,000 animals) to be positive for Brucella antibody. Brucella suis was isolated from the blood of one serologic positive animal. The serologic testing of 697 employees indicated that 49 or 7% had a titer of 1:80 or greater. Of these 26 employees had a titer of 1:80, 2 a titer of 1:160 and 2 a titer of 1:320. The three departments with the highest seropositive rates were maintenance mechanics (25%), hog slaughter (23%) and offal and casing (23%).

Recognition of 13 clinical cases of brucellosis among the employees

of an abattoir in Illinois stimulated an interesting investigation by Schnurrenberger et al. (61), which was studied in 1966. Blood samples obtained from 551 (70.2%) of 783 employees revealed 71 (12.9%) to have positive titers of Brucella agglutinins ranging from 1:25 in 23 sera to 1:64,000 in 3 sera. There were 15 with titers of 1:100 and 18 with titers above this level. The reactive rate was 40% among workers who had contact with pork, 17% among those who had contact with beef reflecting the rate of infection in cattle and swine at that time. Only 5% of the administrative and clerical staff possessed antibodies. Antibodies to Brucella were present in 5% of those who wore glasses and in 19% of those who did not, an indication of infection by droplets introduced into the eyes and the possibility of protection afforded by the wearing of glasses.

Hutchinson (40) described an outbreak of brucellosis which occurred between June 1975 and February 1976 among the employees of a packing plant in El Paso, Texas. The plant employed approximately 500 people. There was evidence that 66 people were infected with Brucella abortus. Cattle came from Arizona, New Mexico and 75% from Texas, and approximately 1,000 animals were slaughtered per day. Possible contributing factors were considered to be: Cleaning procedures between the two shifts consisted of a washdown with water only between shifts with cleaning and disinfectant at the end of the second shift, utilization of a mechanical high puller, reactor cattle not segregated in the slaughter process, the uterus placed on the offal line with other offal, and 2% of cattle slaughtered were reactors.

In the period March through August 1976, 19 cases of brucellosis occurred among 700 workers at a Kansas abattoir (10). Brucellosis had not been recognized in the plant for 20 years. Brucella abortus was isolated from 6 of the workers. This plant slaughters approximately 7,500 cattle and 40,000 swine each month. Factors which led to the epidemic are not clear but must have been the result of contact with infected animals.

It is noted in Table 1 that for the decade 1966-1975, Iowa lead all of the states in the reporting of human cases of brucellosis to the CDC. Over 95% of the reported cases from Iowa are associated with packing plants. The Iowa State Department of Health has reported to the Brucellosis Technical Commission that trace back of infected animals is difficult if not impossible with the present system.

Table 1 reveals that Virginia ranks second to Iowa in the reporting of 347 human cases of brucellosis for the period of pork packing plants. During the period 1970-1976, 170 (91.4%) of the 186 reported cases in Virginia were abattoir associated (53). An investigation in July 1973 revealed that 69 cases of brucellosis had occurred among employees of a swine abattoir in Smithfield, Virginia (13,14) between January 1968 and June 1973. Serologic survey indicated that 33 (9.1%) of 361 workers had evidence of previous infection. A nearby swine packing plant reported

71 cases of human brucellosis between January 1968 and November 1974. Highest attack rates were found in employees of the hog kill, casings, inedibles, and lard departments. The sources of hogs brought to the Virginia abattoir as revealed by the 1974 purchase orders showed that 33.9% of the hogs slaughtered at the plant had originated in North Carolina, 23.7% in Georgia, 19.4% in Virginia, 9.0% in Indiana, 7.0% in South Carolina, 6.6% in Ohio and 0.4% in Illinois. This study reveals the need for cooperative efforts between the states in programs which will eliminate the public health hazard of exposure of people to this disease.

3. PREVENTION

Evidence presented by Buchanan et al. (7) indicates that a single Brucella infected animal may be the source of subsequent human brucellosis by ingestion, conjunctival or skin penetration as routes of infection and that more than 11 infected animals may be sufficient to liberate Brucella aerosols during the slaughtering process to cause human infection by the respiratory route. These workers conclude that eventual elimination of human brucellosis will require eradication in animals. In the interim, efforts to decrease brucellosis in abattoir workers should include evaluation of protective glasses to prevent conjunctival contact, prohibiting ingestion of uncooked animal products within the abattoir and prevention of employees with skin cuts or abrasions from contacting fresh animal blood or lymph with their wounds. They recommend mesh gloves to protect against cuts and water proof first-aid wraps for wounds, and the spacing or prohibiting the slaughter of large groups of seropositive animals to diminish the risk of infection by the respiratory route.

The information developed in the study of brucellosis in swine slaughter houses in California (71) was used as a basis for developing the following recommendations to decrease contact with infected material during slaughter and processing:

(1) Provide impervious disposable gloves or qauntlets in areas where employees are handling potentially infected fresh animal tissue and fluids.

(2) Prevent cuts and abrasions to the skin by wearing protective devices whenever possible. In case of a cut or abrasion, give prompt attention by cleansing, bandaging to protect the cut from contact with infected material until healed.

(3) Provide eye shields, goggles or full face transparent shields in areas where there is potential danger of infecting the mucous membranes of the eyes with contaminated droplets or fluids.

(4) The use of masks or respirators in areas where aerosol trans-

mission could be a factor.

(5) Encourage the washing of hands often during the processing, especially in high risk areas.

(6) Mechanics, as much as possible, should work on equipment only after it has been sanitized by using water at temperature above 180°F (84.4°C).

(7) Establishment of an adequate plant medical program.

(8) The employee must be informed and encouraged to take advantage of the readily available medical services provided by the company in case of suspected illness.

In the report made to the CDC following the investigation of the outbreak of brucellosis among employees of the abattoir in Arkansas City, Kansas, it is stated that the route of infection for the patients was not apparent. No significant difference in skin contact, aerosol or conjunctival exposure was observed between the cases and their matched controls. Ingestion of potentially infectious meat products did not appear to be a factor. Whether protective clothing and equipment commonly used in abattoirs had any influence on risk of Brucella infection was also evaluated. Items evaluated were rubber gloves, rubber aprons, metal-mesh gloves, coveralls, and glasses. No significant difference was found in the frequency with which these items were worn by the patients and their matched controls.

It appears that the method most apt to prevent brucellosis in abattoir employees is the elimination of the infection in animals. With the various means of transmission of the microorganisms and the methods of slaughter and processing of animals, it is difficult to develop a program that will effectively prevent human brucellosis as long as there is infection in the slaughtered animals. Eradication of brucellosis in slaughtered animals seems the only feasible method of prevention of human brucellosis in packing house workers (36).

It is significant that the states of Wisconsin and Pennsylvania have regulations which prohibit the importation of known reactor cattle for slaughter and California has regulations against the importation of infected swine. These regulations are attempts in part to protect the packing house worker from brucellosis.

IV. BRUCELLOSIS IN WORKERS IN THE LIVESTOCK INDUSTRY

1. THE OPPORTUNITY FOR INFECTION

The second largest group, who through exposure to the disease in animals, consist of workers in the livestock industry (veterinarians,

producers, employees), as revealed in Tables 4 and 5. Approximately one fifth of the reported cases of human brucellosis occurs in this occupational group. When infection exists in a herd, there is opportunity for acquisition of the microorganisms from blood, milk, aborted calves, placenta, amniotic fluid and other tissues of the infected animals. Portals of entry of the microorganisms consist of abrasions and cuts on the skin, the inhalation of droplets into lungs, the ingestion of uncooked products and contamination of the eyes. During the time of vaccination of animals with Strain 19 there have been accidents which resulted in injection of viable microorganisms or spraying into the eyes of veterinarians or the assisting worker with subsequent infection.

2. REPORTS OF INFECTIONS

In an attempt to determine the incidence of brucellosis in veterinarians, Schnurrenberger et al. collected blood from veterinarians in Illinois who attended 6 state conventions in the years 1956, 1964, 1966, 1968, 1970, and 1972, and interviewed veterinarians to obtain a history of prior illness diagnosed as brucellosis. There was a history of a diagnosis of brucellosis in 1975 (13.9%) of 1,261 veterinarians. Brucella antibodies were found to be present in a titer of 1:25 and above in 70 (17.8%) of 394 veterinarians. When duplicates were eliminated there was a 17.0% (224/1315) infection ratio. The onset of clinical illness occurred the year of graduation for 13% with 62% occurring 4 years before and 4 years after graduation. There were 81 (46%) infections from cattle, 19 (11%) from vaccine, 9 (5%) from sine, 6 (3%) from other nonspecified and 61 (35%) from unknown sources. A total of 59 (36%) veterinarians reported that they had suffered relapses. The prevalence of brucellosis was found to be decreasing as reflected by the decreasing serologic reactor rates and by decreasing numbers of clinical diagnosis during the period 1956 to 1972, which is in accord with the decreasing incidence in cattle in Illinois during this period. Spink treated two students in the School of Veterinary Science, one veterinarian who had accidentally introduced the organisms into his eyes while vaccinating cattle and one who specialized in obstetrics who had repeated attacks of the disease (63). One survey reported by Pivnick et al. (54) indicated that least 50% of the veterinarians in Ontario who vaccinated calves infected themselves and at least 30% of the infected veterinarians suffered a systemic reaction.

3. PREVENTION

Although the prevalence of the disease in animals has been greatly reduced, possibilities of human infection still exist. It has been observed that as the incidence of possible hazard is reduced, people take fewer precautionary measures. Each worker in the livestock industry should be educated to the hazards of the zoonoses. The avoidance of accidents which result in infection of livestock workers is important. One unpublished work consisted of a study of 1,182 veterinarians and

their accidents (59). Seven different accident types were used as indicators to divide the population into two groups. Those who had experienced one or more of the accidents were more likely to have been infected with brucellosis ($P<0.01$). The suggestion is made that approaching the public health aspects of brucellosis from the prevention of accidents may have merit.

It should be emphasized that if the animals are not infected, brucellosis will not occur in people. Schurrenberger et al. (62) suggested the following steps for individuals in an occupation of high risk that should be taken for protection from brucellosis:

(1) Remain abreast of disease trends and current knowledge about the disease.

(2) Observe good personal hygiene when handling suspect tissues or animals. The use of obstetrical gloves, and other protective equipment when handling potentially infected materials such as retained placentas and aborted fetuses.

(3) Inform your physician of your occupational hazards.

(4) Maintain serologic surveillance on yourself (particularly for veterinarians).

(5) Observe adequate precautions when using strain 19 Brucella vaccine.

(6) Boost brucellosis eradication programs constantly.

There are large groups of people, who work in the livestock and dairy industry, who do not possess the knowledge of the epidemiology of the disease of animals, which are transmitted to man. There are some who are transient, who do not speak English, who do not understand the risks of acquiring brucellosis and who may not know the precautions to be taken. They may not seek medical attention. Their infections with brucellosis may not be reported. Many are not subject to the benefits of workers compensation. There are needs for educational programs of workers to prevent acquisition of brucellosis.

V. BRUCELLOSIS IN PEOPLE WITH OCCUPATIONS NOT DIRECTLY RELATED TO THE LIVESTOCK, MEAT AND DAIRY PROCESSING INDUSTRIES

1. OPPORTUNITY FOR INFECTION

People who are not involved in occupations with livestock, meat and dairy production occasionally become infected with brucellosis. The infection may be acquired from raw meat, raw milk, and raw milk products, ice cream, butter, cream, cheese, yogurt, etc. Visitors to foreign countries, where brucellosis is endemic and pasteurization is

not the custom, may ingest Brucella. There is presently a trend in this country for people of all ages to move to rural areas, and to have a false concept that raw milk and dairy products are more healthful than pasteurized milk and dairy products. Many states allow raw milk and other raw dairy products to be sold directly from the producer-distributor farm (see answers to questionnaire). Yogurt and cheese prepared from unpasteurized milk comes from cows and goats are being sold through stores which advertise "natural foods". This allows potential opportunity for infection of the consumers of these products. City dwellers who visit farms, and who purchase small farms for raising a few animals, may lack information about brucellosis and come into contact with sources of infection. Hunters of feral swine, deer, caribou or moose may also acquire infection from contact with infected animals. Mechanics and welders may acquire the infection while working with equipment, trucks, cattle cars, etc. if there is contamination by infected animal products. It is known that laboratory workers acquire brucellosis by accidents while working with specimens of blood and tissues from infected animals and with cultures of Brucella.

There have been attempts to determine the incidence of brucellosis in the general population. In 1955 when opportunity for exposure was great, a study indicated that 13.7% of the butchers in the United States had contracted brucellosis (70). Ten years later a survey of 846 premarital and prenatal blood samples for Brucella antibodies in Illinois residents in 1965 did not detect a single reactor, as supported by Schnurrenberger et al. (60), because of little potential of exposure. The decrease in opportunity for exposure has resulted from the improved programs undertaken by industry, public health agencies, veterinarians, physician, educators and many concerned people. Without safeguards to protect the public health, there would be increased opportunity for exposure of the general population to brucellosis. Butchers, chefs, and cooks who handle raw meat and taste seasoned sausage, individuals who eat raw meat or milk products, and the many people who wrap, package and deliver meat are at some degree of hazard. Sadler (58) has emphasized the potential role that meat may have in the exposure of the general population to brucellosis and the possibility of unrecognized infections among this group.

2. REPORTED CASES

Data on reports of brucellosis of people whose occupations are not primarily related to the livestock and meat processing industry for the decade 1965-1974 are listed in Tables 4, 5, 8, 10 and Figure 2. It can be seen in Table 10 that 620 infections were reported during the decade 1965-1974. The greatest number had sources of infection which were unknown in 37.6%. Foreign dairy products were the source in 20.2%. In the 2 years 1975-1976, there were 34 cases reported which were attributed to foreign dairy products including raw milk or cheese from Mexico (24 cases), Italy (4 cases), Greece (3 cases), India (1 case), France (1

case), and Thailand (1 case). Domestic dairy products were the source in 9.2%. In the 2 years, 1975-1976, there were 14 reported cases which were traced to unpasteurized milk or milk products produced in the United States. Laboratory accidents resulted in a total of 40 cases, 34 (5.5%) in the period 1965-1974, 1 in 1975 and 5 in 1976. Hunters acquired the infection from feral swine in 7 cases during the period 1965-1974 and only one case has been reported subsequently. There have been 12 instances of caribou or moose as a source during the decade 1965-1974, and in 1975 a case was reported in Alaska of brucellosis following the eating of bone marrow from caribou. Deer have been the source of reported infection only 3 times since 1965, the last case reported in a hunter in Texas in 1975 (11,12).

There has been recent medical interest in brucellosis acquired from dogs with infection by Brucella canis. This infection has been rarely reported in human beings. One case was reported in a woman in 1976, whose dog had aborted during the month prior to the onset of her illness which brought the total number of reported infections caused by Brucella canis to 17 since the first case was reported in 1967 (12).

3. PREVENTION

The prevention of brucellosis in this group of people will require education of the general population. There needs to be better understanding of the hazards of ingesting raw dairy products (milk, cheese, ice cream and yogurt) and particularly by visitors to foreign countries. Hunters should take precautions when dressing wild animals. Laboratory workers should be aware of the hazards and develop protective methods which will reduce the incidence of laboratory-acquired infections. The eradication of brucellosis from animals of this country would of course eliminate cattle, swine, sheep and goats as the sources of human infection except for those acquired in foreign countries.

VI. TRENDS IN THE CHANGING INCIDENCE OF HUMAN BRUCELLOSIS, 1947 - 1976

1. THE YEARS OF STEADY DECLINE OF HUMAN BRUCELLOSIS IN THE UNITED STATES, 1947 - 1973

The incidence of brucellosis in humans reached a peak in the United States in 1947 when 6,321 cases were reported, (4.4 cases per 100,000 population). World War II was over. Demands of public health brought monies and manpower to implement the State-Federal Cooperative Brucellosis Eradication Program, which had been established in 1934 with the passage of the Jones-Connally Bill to prevent this disease in humans by elimination of the disease in animals. The endeavors of agricultural and public health agencies, epidemiologists, veterinarians and the livestock and dairy industries have been effective in reducing the number of infected cattle and dairy herds and the infections of swine. Concurrent with the decreasing incidence of brucellosis in animals, there has been

a decrease in the incidence of the infection in people. The number of reported cases in 1973 reached the lowest figure of 173 as observed in Figure 1 and Table 3. Some states reported no human infections in 1973. These trends are noted in many states.

2. THE EFFECT OF ERADICATING BRUCELLOSIS IN ANIMALS ON THE INCIDENCE OF HUMAN DISEASE

For the purpose of studying the effects of various factors which influence the incidence of brucellosis in humans, the experiences that have been reported from five states, Minnesota, California, Florida, Texas and Vermont are examined:

(1) HUMAN BRUCELLOSIS IN MINNESOTA

Held, Bauer and West correlated the incidence of reported cases in humans in Minnesota with the eradication of brucellosis in cattle in the state from 1927 to 1956 (35). The Minnesota Legislature enacted a law authorizing the State Livestock Sanitary Board to control and eradicate brucellosis in cattle by means of an area plan in 1939. A law requiring pasteurization of milk was enacted in 1949 and a regulation prescribing minimum standards for grade A milk became effective under that law in 1952. By 1956 all counties in the state were operating under the plan.

It can be seen in Figures 4-7 that from 1927 to 1948, when numbers of cattle increased or decreased, there was usually a corresponding increase or decrease in the number of human cases of brucellosis. From 1949 to 1956 this relationship was no longer evident. From 1950 to 1956 the number of human cases declined in spite of an increase in the population of cattle. They reported that the human case rate for brucellosis was 3.12 times greater in noncertified areas than in certified areas.

The number of human cases of brucellosis reached a peak at 403 cases reported in 1946. There was a decline over the next decade to 63 cases reported in 1956. Then followed a gradual reduction as the program of eradication achieved success to 4 or less cases per year after 1970 with no human brucellosis reported in the two year period, 1974-1975. One case was reported in 1976 (12).

(2) HUMAN BRUCELLOSIS IN CALIFORNIA

Observations of the program in California (71) reveal an impressive decline in reports of human brucellosis over the years from a peak of 335 reported cases in 1943 to a low level of 11 reported cases in 1959. Table 11 indicates the steady decline in the incidence of reported cases and deaths due to brucellosis in California as correlated with dates of the program of eradication of brucellosis in cattle (70).

A significant but unknown proportion of human brucellosis in California prior to 1955 were milk borne infections resulting from consumption of raw milk from infected cattle. The annual incidence of reported cases has been consistently between 14 and 29 during the years 1959 to 1976. Since the main sources of human brucellosis in California initially were cattle and unpasteurized dairy products, the most important factor in reducing the incidence of the disease in people was the eradication of brucellosis in cattle and the pasteurization of milk. As this program achieved success, human brucellosis in California became predominately an abattoir-associated disease. In 1970 California reported a total of 18 cases, 7 (39 percent) of which were associated with slaughter houses. Of the remaining 11, most were traced to foreign exposure.

In 1971 Californians consumed pork and pork products from over 6 million hogs a year of which 1.6 million (25 percent) were slaughtered within the state. Ninety percent of the swine slaughtered in California were shipped from other states primarily Nebraska, Missouri, Iowa and Kansas. California moved far ahead in eliminating brucellosis from its swine population. In 1971, of the 189 validated swine brucellosis-free counties in the United States, 57 or over 30 percent were in California. Thus, out-of-state hogs became the primary source of brucellosis in California slaughter plants. As a result of this situation, California instituted regulations in 1973 which attempted to preclude the importation of swine into the state, however, enforcement has not been successful and some Californians persist in exposing themselves by consumption of foreign unpasteurized raw dairy products. The majority of human brucellosis detected in California during the years 1965-1975 has been from exposure to animals or dairy food products originated outside or consumed outside of California. Concurrent with the increase of the disease in California cattle, there has been a corresponding increase in human brucellosis contracted from animals.

(3) HUMAN BRUCELLOSIS IN FLORIDA

Bigler et al. (5) have recently reported "Trends of Brucellosis in Florida". Human brucellosis in Florida is documented for the 50 year period, 1928-1978. There were 936 reported cases of human brucellosis during the period 1930-1975 with the peak period occurring in the decade 1940-1949 when more than half of the cases, 505, were reported. After 1949, the program of eradication of animal brucellosis was begun, and the incidence of human brucellosis declined rapidly with 116 cases reported in 1950-1959 and 44 cases in the decade 1960-1969. Most of these cases of human brucellosis were believed to be related to infections in cattle and swine.

Of the cases occurring during the period 1963-1975, 44.3 percent were related to the livestock producing industry and 16.4 percent were associated with the meat processing industry. Housewives, hunters, students and children accounted for 27.9 percent and 11.5 percent did

not fall in any of these categories. When the sources of infection were identified, swine accounted for 39.3 percent, cattle 31.1 percent and both cattle and swine 9.8 percent. Unpasteurized dairy products, vaccine, one dog and unknown sources accounted for the remaining 19.8 percent.

Florida had an increase from 3 reported cases in 1973 to 7 in 1944, and 21 in 1975. The 28 cases in 1974-1975 occurred in both the animal industry and nonindustrial sectors of the population. In 1977, a testing program was conducted in the Okeechobee area with collection of 80,349 blood specimens from cattle, in which the overall cattle infection rate was 5.4 percent; of 23 employees of the federal-state program at risk, 3 developed brucellosis and 2 others developed infection with Strain 19 by accidental injection (26).

Fifty-six percent of the reported human cases in 1974-1975 involved swine. Five of these were associated with the livestock industry, 4 were consumers and 6 were hunters. All human brucellosis derived from cattle were in counties not certified free of brucellosis. Human brucellosis derived from swine in Florida is associated with infected domestic swine as well as with feral swine. Producers of domestic swine in Florida have their animals tested for brucellosis only on a voluntary basis, and swine-derived human cases occur not infrequently in counties certified free of bovine brucellosis.

Feral swine were the source of brucellosis in 6 hunters and are present in 66 of the 67 counties (4,28,78). Testing of 61 feral swine killed by hunters revealed 2 positive and one suspicious for brucellosis, however, 31 hogs trapped in an area of high density of feral swine in Florida were reported to be positive in 48 percent (74). A study reported by Wood et al. (82) of 255 feral hogs in the lower costal plain of South Carolina revealed a reactor rate of 18 percent.

(4) HUMAN BRUCELLOSIS IN TEXAS

Interstate Highway 35 extends from the Red River near Gainesville, Cook County, Texas to the Rio Grand at Laredo, Webb County, Texas and passes through Fort Worth, Waco, Temple, Austin and San Antonio. This highway divides Texas into western and eastern portions. Information presented by Lerro (45) indicates that the Texas State Statute for the Brucellosis Eradication Program was adopted in 1959, and the testing program was initiated in the Big Bend Country, which is west of Interstate Highway 35, and that the program of eradication moved from the western part of the state to the eastern part as each county was cleared of infected cattle. Figure 8 shows the wide distribution of 460 reported cases of human brucellosis for 1947 before the program of eradication was initiated. There was a decrease in the number of reported cases of human brucellosis from a peak incidence of 561 cases in 1948 to approximately 20 cases in 1957 and to a low of 12 cases in 1965. After 27 years of progressive decrease in the incidence of human brucellosis,

there was a reversal of trend with 31 cases reported in 1975 (11) and 67 in 1976 (12).

Figure 9 shows the distribution of 132 cases of human brucellosis reported for the period 1970-1975 after the program of eradication had been in effect over a decade. This reveals that prevention of human brucellosis was achieved in more counties in the western portion of the state than in the eastern portion. Only 8 cases of human brucellosis were reported from the area west of Interstate Highway 35 for the five year period 1970-1975, except for a focal concentration of cases in El Paso County due primarily to persons eating fresh goat cheese and unpasteurized milk from Mexico (45). In contrast, 86 cases of human brucellosis were reported from the eastern portion of the state during the same period.

Jones (42) has reviewed the "Brucellosis Infected Problem Herds in Texas" and points out that brucellosis has not been eliminated from many cattle herds in East Texas and intraherd transmission of the disease has continued for many years, one reason being a lack of basic information and knowledge about the disease by livestock producers and regulatory field personnel, or the failure of field personnel to communicate the facts about brucellosis to producers. It is significant that there were more quarantined herds in Texas, 3,093, as of May, 1976, than any other state, and most of these were in eastern Texas (79).

(5) HUMAN BRUCELLOSIS IN VERMONT

As some states brought the incidence of brucellosis in cattle to the point of eradication, the disease was eliminated in people, only to have infected cattle reintroduced from another state or country with the reappearance of human brucellosis. As an example of this phenomenon, the history of Vermont is illustrative (15). Efforts to control bovine brucellosis were initiated in Vermont in 1935 with voluntary testing of herds. The programs led to identification of infected herds and in 1946, 23,008 reactor cattle were identified for mandatory slaughter. By 1957 the number of reactor cattle had dropped to 5,504. Vermont acquired the status of a Modified Certified Brucellosis Area in 1957. In 1965 only 41 reactor cattle were found and in the period 1966 to 1972 only a few reactor cattle were detected. No cases of human brucellosis were reported from Vermont after 1965 until 1975 when 6 cases were reported. The 6 cases were associated with ingestion of raw milk and occupational exposure of livestock workers to vaginal and uterine secretions of cattle in herds found to have multiple Brucella reactor cattle. Vermont reported an outbreak of bovine brucellosis in 1973-1974 which was traced to the importation of cattle from Delaware, and in 1974-1975 another outbreak of bovine brucellosis was thought to be associated with the importation of infected cattle from Canada.

3. THE RECENT YEARS OF INCREASING INCIDENCE OF HUMAN BRUCELLOSIS IN THE UNITED STATES, 1974-1976

A significant but not surprising observation is apparent. There was a steady decline of brucellosis in animals in the United States following the initiation of a program to eradicate brucellosis. Correlated with this trend was a steady decrease in the number of reported cases of human brucellosis as seen in Table 3 and Figure 1. As seen in Figure 10, the bovine brucellosis reactor rates found in market cattle testing began to increase after 1971 (77), approximately two years before the increase in the incidence of human brucellosis became apparent. With the incidence of brucellosis in both cattle and people showing a steady decline over many years this change adds support to the direct relationship of the disease in animals and human beings (36). The reasons for the reversal of these correlated trends are discussed elsewhere in this report.

VII. ECONOMIC CONSIDERATIONS OF HUMAN BRUCELLOSIS

It is difficult to determine the economic loss to the gross national product of human brucellosis in the United States. As stated, the actual number of cases is unknown for the majority of human cases of brucellosis are not diagnosed and are not reported. For an individual case it is possible to determine such direct costs as the expense of the physician, hospital, laboratory tests, medications, and follow up visits. Indirect costs, such as time lost from work, costs of replacement, and payments to the employee can be determined. It is difficult to determine the losses associated with pain and suffering, losses to members of the patient's family, relatives and friends, and the decreased proficiency of the affected person as a result of the illness.

A study by the California Department of Health (70) in 1975 estimated costs using the following data: "For direct costs in 1974 the average cost for a day spent in a community hospital was $110.77, the average length of time hospitalized was one week for a patient requiring hospitalization. Costs due to medication, for a period of two weeks were conservatively estimated at $50. Using these figures, the average direct costs for a case of human brucellosis is calculated to be (22%) ($110.77/day) (7 days) & (78%) ($50) = $220. When considering the indirect costs associated with a human case of brucellosis, we will use 45 days as the average amount of time lost from work and $159.41 per week as the average salary per patient. Using these figures we arrive at the average indirect costs for a human infection. The sum of direct and indirect costs associated with human cases of brucellosis in fiscal year 1976 in California is estimated to be $23,156. However, with the cessation of the bovine brucellosis program these costs could reach the annual level of $438,310 by 1990."

These estimates are considered to be conservative in view of the observations of Faber (22) who collected data at a packing plant in Iowa in 1977. Listed below is the data submitted by Dr. Faber, which does not include cost items for physicians nor for hospitalization as there were none. The number of cases was 21 patients, however, one of these was a USDA inspector who did not figure in the cost items.

Number of patients	20
Average days of work lost per case	948/20 47.4 days
Range of illness	0 days to 296+
Average days of hospitalization	0
Cost including physicians	-
Hospitalization	-
Medications	- below
Follow up care	- below
Replacement	- below
Loss of productivity	- below
Insurance and work compensation payment	- below

Direct costs		
(1)	948 days lost at $79.45 per day	$75,318.60
(2)	First aid supplies	
	20 Lost time cases x $90.64	1,812.80
	1 Case no lost time x $2.37	2.37
(3)	Reinsurance cost $98.74 x 20	1,974.80
		$79,108.57
Indirect costs		
(1)	8 monts testing; twice month; .5 hrs. lost/test 8 x 2 x .5 x $9.69 x 20 (cases) =	$ 1,550.40
(2)	8 months testing as above at $.50 lab cost 8 x 2 x $3.50 x 20	1,120.00
(3)	3 months testing on first aids twice a month: .5 hrs lost/test 3 x 2 x .5 x $9.69 x 1 (first aid cases)	29.07
	Indirect costs	$ 2,699.47
(4)	3 x 2 x $3.50 lab fees	21.00
Total losses due to Brucellosis		$81,829.04
Average cost per case		$ 4,095.45

Items not counted in costs:

Company physicians
Four nurses
One medical technician
Insurance department personnel
Safety department personnel

In an earlier report for 1976, Faber reported costs including the above plus the expense of hospitalization and physician for 47 cases at a total of cost of $217,000 or an average cost per case of $4,617.

If the cost of each human case is estimated to be $4,095 and this figure is applied to the 282 reported cases in the United States for 1976, the costs of reported human brucellosis is estimated to be approximately $1,154,790 for the year. The cost of cases which are not reported cannot be estimated with meaningful accuracy.

VIII THE EDUCATION OF PHYSICIANS IN AN UNDERSTANDING OF BRUCELLOSIS

An understanding of the unique characteristics of brucellosis by physicians and their cooperation in reporting infections of their patients to public health officials is important to the success of programs of control or eradication of brucellosis in this country. It is the personal experience of the physician member of the National Brucellosis Technical Commission that a request of a physician for "febrile agglutinins" will result in an agglutination test using Brucella antigen in most hospital and public health laboratories. However, experience and knowledge of the use of the double media in the Castaneda bottle for blood cultures (9,63) appears to be lacking. This deficiency may result from the routine habits of many physicians who order "blood culture times three" without specifying that brucellosis is a possible diagnosis. Brucella are not apt to be isolated and recognized in a routine blood culture as performed in most hospital laboratories.

A review of the teaching in medical textbooks used by physicians and medical students reveals variations in the subject of brucellosis. It is of interest that the textbook by Beeson and McDermott, Textbook of Medicine, of 1975 which is well done, makes the optimistic statement that: "Present programs in the United States to control the disease in cattle and pigs are succeeding and the disease is expected to disappear here in the next few years. Elsewhere control measures are less advanced. The major prevention measures for the general population is to consume only pasteurized dairy products. There is no way to prevent spread of infection to workers from infected animal or animal tissues."

The textbook, Harrison's Principles of Internal Medicine (31) of 1974 in an excellent chapter on brucellosis states, "As long as a reservoir of brucellosis persists in domestic animals human brucellosis will occur. The only practical means of eliminating the disease in human beings is to eradicate the disease from cattle, hogs, sheep and goats. Control measures in animals are being worked out in several areas of the United States. Since human brucellosis may be contracted through the ingestion of contaminated milk and milk products, it is essential that only properly pasteurized milk be utilized for human consumption. Brucellosis is an occupational disease involving farmers, livestock workers, veterinarians, and those working in meat-packing

plants, and there is no entirely safe means for immunizing these groups against the disease."

A review of the textbook, The Biologic and Clinical Basis of Infectious Diseases, by Youmans, Paterson, and Sommers states that the usual method of human infection of brucellosis is "milk, direct or indirect contact" and lists as common animal hosts: "Cattle, goats, swine, sheep, horses, mules, dogs, cats, fowl, deer, and rabbits." This textbook presents only two outbreaks of human illness, one a woman hospitalized in Colorado from whom Brucella melitensis was cultured and who was treated with ampicillin, kanamycin and tetracycline. Her sister who had a febrile illness with one serum specimen revealing a Brucella agglutination titer of 1:320, was treated with kanamycin. They had eaten goat cheese from Juarez, Mexico.

The other outbreak described consisted of members of a family in El Paso, Texas. Brucella melitensis was isolated from one, and all symptomatic members had elevated Brucella agglutinin titers. No treatment is described. The family had eaten cheese purchased in Juarez, Mexico. This textbook does state that "brucellosis in the United States today occurs predominantly in workers in the livestock and meat processing industry; in recent years, about 15 percent of reported cases have been associated with the ingestion of presumably unpasteurized dairy products."

In review of this latter textbook there is concern that the medical student or uninformed physician may erroneously conclude that: (a) horses, mules, cats, fowl, and rabbits are as apt to be reservoirs for human brucellosis as are cattle, swine, and goats, (b) Brucella melitensis from goat cheese purchased in Mexico is the usual source of brucellosis in the United States, (c) one specimen for the agglutination test is satisfactory rather than two specimens taken two weeks apart, and that ampicillin, kanamycin and tetracycline or kanamycin alone are the preferred antibiotic modes of treatment.

There is an apparent need for physicians, particularly in the states with the highest incidence of bovine brucellosis, to have greater understanding of human brucellosis. This is particularly true in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas. It would be helpful to the success of the programs of eradication of bovine and human brucellosis if there could be a concerted effort to obtain the aid of the public health agencies, medical schools, state and county medical societies, and the local medical journals in informing the physicians of these states about human brucellosis, its recognition, management, and prevention.

IX. RATIONALE FOR LEGISLATIVE ACTIONS TO PROTECT THE PUBLIC HEALTH FROM BRUCELLOSIS

Because of the hazards of brucellosis to the public health and economic loss to the industry, legislative actions have been taken in many states and countries throughout the world to control or eradicate the disease in animals. The following material is from the California report of 1975 (70), and is illustrative of legislative rationale in this field. The thesis is that "there are direct benefits to the public health and interest in the control of animal diseases."

"At issue is the ability of public agencies through the enforcement of such standing laws, or possibly the introduction of new laws, or the amendment of existing laws, rules and regulations that will guarantee wholesome food products to the general public and maintain the health and safety of workers in cattle and swine-related industries."

"Since eradication of brucellosis in livestock has a direct bearing upon the control of brucellosis in human beings, the public agencies of government have a responsibility to assist in the eradication of this disease. The public agencies have a statutory duty to protect the interests of the general public, the consumer and the animal industries by insuring the production and distribution of wholesome food products."

An example of legislative opinion is expressed by the following statement from the California statute: "The Legislature finds and declares brucellosis is a severe and debilitating disease in human beings and is a serious disease of cattle, swine, sheep and goats. Elimination of brucellosis in California is of public benefit since human beings contract the disease directly from animals or their products, and it is necessary to provide protection to both the livestock industry and the public health.

The Legislature therefore, declares that livestock infected with or exposed to brucellosis are a public nuisance as a threat to other livestock and to human health. The Legislature, therefore, declares that the eradication of brucellosis must be expedited.

It is, therefore, the intent of the Legislature that the owner of an infected herd of cattle who does not diligently pursue the eradication of brucellosis from his herd in cooperation with his veterinarian, other cattlemen and the department, shall be responsible for paying the director the full costs of the department for all brucella eradication efforts in his herd in accordance with the provisions of this article. Payments of such costs shall not excuse compliance with the provisions of law, regulations and order of the director, nor be a defense in criminal or civil actions" (70).

The Grade "A" Pasteurized Milk Ordinance - The requirements of the ordinance (8) is not well understood in regard to Section 8, Animal

Health, which in part states: "All milk for pasteurization shall be from herds under a brucellosis eradication program. All reactors disclosed on blood agglutination tests shall be separated immediately from the milking herd; the milk of these reactors shall not be used for human consumption." It appears logical and to be in the interest of public health that milk presented for pasteurization should come from healthy cows.

Swine Brucellosis: Interstate Movement and Exposure of Packing Plant Workers to Brucellosis - The following is an example of legislation that was adopted by the California Legislature in 1971 which was intended to reduce the hazard of brucellosis in packing plant employees (70).

"795.32 Swine Brucellosis: Interstate Movement after January 1973"

(a) The Director finds, after consultation with the Director of Public Health, that swine brucellosis is a serious disease transmissible from infected swine to human beings; that such infection is a hazard to the health of persons coming in contact with such animals or their carcasses; that swine brucellosis is controlled in California and so recognized by validation by the United States Department of Agriculture; that the disease is not controlled in other major swine producing states; and that the requirements of this section and Paragraph (c) of Section 795.30 are necessary for protection of the public health and the swine industry of this state. The immediate imposition of the restrictions provided by this section and Paragraph (c) of Section 795.30 would so seriously reduce the source of supply of hogs to California as to make immediate restrictions impracticable and contrary to the public interest by denying an adequate supply of pork to consumers. The delay will permit other swine producing states to expand their programs to eliminate the disease in their swine herds. The Director will work with the United States Department of Agriculture and Departments of Public Health and Industrial Relations to reduce exposure to the disease to workers in California slaughter plants.

(b) On or after January 1, 1973 all swine brought into California for any purpose shall be accompanied by an official health certificate showing such swine originated in a validated brucellosis-free herd so recognized by the Livestock Sanitary Official in the State of origin or a herd not under quarantine for brucellosis in a validated brucellosis-free area."

X. RATIONAL FOR WORKMAN'S COMPENSATION

The following material was developed as a part of the Brucellosis Study in California in 1975 (69) and has been modified for use in this report:

Is undulant fever (brucellosis) in human beings a public health problem?

California Department of Labor Code, Section 3600, P. 361 (193) Issue

Should Workman's Compensation payments be made to persons contracting brucellosis?

Definition: Workman

One who labors

One employed to do business for another

(Harris v. City of Baltimore, 151 Md. 11, 133, A88 Section 9)

Workman - Related to Workmen's Compensation

One who engages to furnish services subject to the control of an employer (i.e. master/servant relationship - Agency Law). The employee is subject to the complete control of the details of the work (e.g. a contract for personal services). (Landberg v. State Industrial Accident Comm. 107, Or. 498, 215, PP. 594-596)

Intent of Act

"It is not health insurance and was not intended to compensate for disability through sickness or disease not caused by accidental injury arising out of and in the course of his employment. (Gumtow v. Kalamazoo Motor Express Co., 266 Mich. 16, 253, N.W. 198)

California Labor Code: Conditions of Liability Issue

Would the injured or disease employee be equally exposed to the hazard apart from his employment? Is the hazard apart from his employment? Is the hazard common to entire community or one which by reason of the nature of employment was greater than the risk to which the public in general was exposed?

Commonality Doctrine

Where the risk is not naturally incident ot employment, plaintiff must prove peculiar exposure to the danger of injury or infection by reason of employment only. (Ketron v. United R.R. of San Francisco (1914) 11A C Pt. 2 528)

Public Health v. Workman's Compensation

Does the employment necessarily increase danger to a higher degree than to which persons generally are subjected?

There must be such special exposure to such danger as warrants a conclusion that the accident or disease arose out of employment.

Section 3600: Note 377, P. 395

"Special exposure of contagious disease cannot be held to be proximate cause rising out of employment without special exposure. (Fidelity and Casualty Co. of N.Y. v. Industrial Accident Comm., 1927, 258, P. 698, 84 C.A. 506, P. 400: Div. 4, Pt. 1)

Section 385 - Undulant Fever

Case Law

Undulant fever contracted by meat loader in packing plant arose out of the course of employment. (MacFarlane v. Swift Co., 1934, 20, 1 A C, 28)

Case Law

Undulant fever contracted by packing plant worker who handled animal carcasses arose out of and in the course of employment. (Woody v. Cudahy Packing Co., 1934, 20, 1 A C, 27)

Case Law

Undulant fever contracted by ranch hand did not arise out of and in the course of his employment. (Manty v. Tanner's Dairy, 1932)

Case Law

Undulant fever contracted by slaughter house employee arose out of employment. (Brown v. San Joaquin Valley Meat Co., 1933, 19, 1 A C 53)

Case Law

Undulant fever of dairyman working around his diseased cattle arose out of employment. (Olds v. Kieg, 1946, 11 Col., Comp. Cases 164)

Example

Where meat-packing employee developed undulant fever two weeks after he had incurred an open wound in finger while at work. Employee since his injury:

(a) worked with refuse of slaughtered animals

(b) drank no milk

(c) kept no cows or goats

Finding

Disability was compensable.

Conclusion

By definition and findings of case law, courts hold in a majority of jurisdictions that in order to be compensable the illness or accident must be:

(1) work related,

(2) a condition the general public is not commonly exposed to.

Thus, undulant fever appears to be considered to be a work-related disability and in most cases falls under the statute of workman's compensation.

Workman's Compensation Laws: S. 41.70 (Fed.) Continuing Legislative Expansion of Coverage

Since 1950, the number of states having occupational disease coverage by legislative action has grown from 44 to 50 and the number having general coverage has risen from 27 to 43.

Brucellosis is listed in the compensation laws of:

Colorado

Iowa

Kansas

North Carolina

Puerto Rico

Virginia

Wyoming

California Department of Occupational Health and Disease Control
Section 25960 (new)

Local health departments shall provide services in occupational health to promote the health of employed persons including:

(a) Educational

(b) Consultative

(c) Statistical

(d) Investigative

(e) Other appropriate activities

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TABLE 1

REPORTED CASES OF HUMAN BRUCELLOSIS IN THE UNITED STATES IN 1976 AND 1966 THROUGH 1975[12]

	1976	1966-75		1976	1966-75
Alabama	3	15	Nevada	0	0
Alaska	0	17	New Hampshire	0	3
Arizona	0	2	New Jersey	1	18
Arkansas	9	57	New Mexico	0	18
California	19	222	New York	5	31
Colorado	5	15	North Carolina	1	20
Connecticut	2	12	North Dakota	1	16
Delaware	0	1	Ohio	1	25
Florida	6	49	Oklahoma	5	73
Georgia	1	127	Oregon	1	10
Hawaii	0	6	Pennsylvania	0	47
Idaho	1	9	Rhode Island	0	3
Illinois	3	107	South Carolina	0	12
Indiana	0	11	South Dakota	1	14
Iowa	38	372	Tennessee	13	95
Kansas	25	27	Texas	67	224
Kentucky	2	13	Utah	2	7
Louisiana	4	45	Vermont	0	5
Maine	0	1	Virginia	26	347
Maryland	1	12	Washington	3	10
Massachusetts	1	20	West Virginia	0	3
Michigan	1	23	Wisconsin	8	35
Minnesota	1	58	Wyoming	0	1
Missouri	5	40	Puerto Rico	0	0
Mississippi	3	39	Virgin Islands	0	0
Montana	2	13	Guam	1	1
Nebraska	3	47	D.C.	0	1
			TOTAL	271	2379

TABLE 2

RESULTS OF BLOOD CULTURES FOR BRUCELLOSIS

ON 222 PATIENTS, UNITED STATES 1975-1976 (11, 12)

Results	No. of Patients	Percent of Total
B. suis	53	23.9
B. abortus	52	23.4
B. melitensis	10	4.5
Brucella sp	14	6.3
B. canis	1	0.5
Negative	92	41.4
Total Cultures	222	100.0

TABLE 3

REPORTED CASES OF BRUCELLOSIS IN HUMANS

IN THE UNITED STATES 1947 - 1976 (76)

YEAR	NUMBER	YEAR	NUMBER
1947	6321	1962	409
1948	4991	1963	407
1949	4235	1964	411
1950	3510	1965	262
1951	3139	1966	262
1952	2577	1967	258
1953	2032	1968	251
1954	1823	1969	234
1955	1444	1970	235
1956	1300	1971	190
1957	983	1972	188
1958	924	1973	175
1959	892	1974	247
1960	751	1975	328
1961	636	1976	282

Table 4

309 Cases of Brucellosis by Occupation and Most Probable Source of Infection, United States, 1975[11]

CLASSIFICATION	OCCUPATION	MOST PROBABLE SOURCE OF INFECTION													
		Domestic Animals				Wild Animals			Unpasteurized Dairy Products		Accidents				
		Swine	Cattle	Swine or Cattle	Unspecified Farm Animals	Deer	Caribou	Feral Swine	Domestic	Foreign	Strain 19 Vaccine	Laboratory	Unknown	Total	% of Total
Meat Processing Industry	Packing House Employee	77	47	44	2	–	–	–	–	–	–	–	–	170	55.2
	Government Inspector	2	6	4	1	–	–	–	–	–	–	–	–	13	4.2
	Rendering Plant Employee	–	–	1	1	–	–	–	–	–	–	–	–	2	0.6
Livestock Industry	Livestock Market Employee	–	1	–		–	–	–	–	–	–	–	–	1	0.3
	Livestock Producer	11	39	1	–	–	–	–	2	–	1	–	–	54	17.5
	Veterinarian	–	2	1	–	–	–	–	–	–	1	–	–	4	1.3
Other Categories	Laboratory Worker	–	–	–	–	–	–	–	–	–	–	1	–	1	0.3
	Housewife	–	1	–	–	–	–	–	2	1	–	–	1	5	1.6
	Student or Child	–	2	–	2	–	–	–	2	5	–	–	3	14	4.5
	Other	3	6	2	–	–	1	4	2	9	–	–	9	36	11.6
	Unknown	1	–	–	–	1	–	–	–	1	–	–	6	9	2.9
Total		94	104	53	6	1	1	4	8	16	2	1	19	309	100.0
% of Total		30.6	33.7	17.2	1.9	0.3	0.3	1.3	2.6	5.2	0.6	0.3	6.1	100.0	

TABLE 5

132 CASES OF HUMAN BRUCELLOSIS BY OCCUPATION AND MOST PROBABLE SOURCE OF INFECTION
TEXAS, 1970-1975[45]

		MOST PROBABLE SOURCE OF INFECTION							
Classification	Occupation	Swine	Cattle	Domestic Raw Milk	Dog	Unknown	Unpasteurized milk, fresh cheese	TOTAL	Percent of Total
Meat Processing Industry	Packing House	2	27					29	22.0
	Rendering Plant	1	2					3	2.3
	Govt. Inspector		4					4	3.0
Livestock Industry	Livestock Producer		24					24	18.2
	Livestock Market Employee		2					2	1.5
	Veterinarian	-	-					-	-
Other Categories	Housewife		-	1		9	6	16	12.1
	Student or Child		-	-		1	9	10	7.6
	Other	1	4	2	1	10	26	44	33.3
	Unknown	-	-				-	-	-
TOTAL		4	63	3	1	20	41	132	100%
PERCENT OF TOTAL		3.0	47.7	2.3	0.7	15.2	31.1		100%

TABLE 6

REPORTED CASES OF BRUCELLOSIS IN ABATTOIR EMPLOYEES AND MEAT INSPECTORS, MOST PROBABLE SOURCE CATTLE, 1970 - 1975

STATE	1970	1971	1972	1973	1974	1975	TOTAL
Arkansas				1			1
California		1		1	1	3	6
Colorado			2				2
Florida					1	2	3
Georgia	1				3	1	5
Idaho						1	1
Illinois			1		1		2
Iowa	4		5	5	6	12	32
Kansas					1	3	4
Kentucky						1	1
Louisiana			2	1			3
Minnesota		1					1
Mississippi			1		2	3	6
Nebraska	1	1	2				4
New Jersey						1	1
New Mexico				2		1	3
Oklahoma	2	1					3
So. Carolina					1		1
So. Dakota						1	1
Tennessee			1	1	1	4	7
Texas			1	3	3	12	19
Utah						2	2
Wisconsin	1		1	3		6	11
TOTALS	9	4	16	17	20	53	119

Source: CDC Reports

TABLE 7

REPORTED CASES OF BRUCELLOSIS IN LIVESTOCK PRODUCERS,
VETERINARIANS AND OTHERS EXPOSED TO LIVE CATTLE
MOST PROBABLE SOURCE CATTLE 1970-75

	1970	1971	1972	1973	1974	1975	TOTAL
Alabama		1	2			1	4
Arkansas		1	1	4	5	9	20
California			1		1	1	3
Florida				1	2	8	11
Georgia	1		2	7	2	3	15
Idaho		1	1		1	2	5
Illinois	1			1	2		4
Iowa		1				2	3
Kansas			1	1			2
Kentucky			1		2		3
Louisiana		1			1	3	5
Minnesota	1		1				2
Mississippi		2		2	3	1	8
Missouri	1	1	1		2		5
Montana				3	2	2	7
Nebraska				3	1		4
New Hampshire			1				1
New York				1			1
Ohio			1	1	1	2	5
Oklahoma	1		2		8		11
Oregon						2	2
Pennsylvania						2	2
South Dakota		1					1
Tennessee		1	2		3	3	9
Texas	7	2	3	4	11	6	33
Utah						1	1
Vermont						2	2
Washington						1	1
Wisconsin				1			1
TOTALS	12	12	20	29	47	51	171

Source: CDC Reports

TABLE 8

REPORTED CASES OF BRUCELLOSIS IN HUMANS
MOST PROBABLE SOURCE INGESTION OF RAW
DOMESTIC DAIRY PRODUCTS 1970 - 1975

STATE	1970	1971	1972	1973	1974	1975	TOTAL
Alabama		1					1
Arkansas			1				1
California		1			2		3
Illinois						1	1
Louisiana			1	2		2	5
Michigan		2					2
Minnesota			1				1
Missouri		1			2		3
Montana					1		1
Ohio					1		1
Oklahoma				1			1
Tennessee					1		1
Texas	3				1	2	6
Vermont						3	3
Wisconsin	1						1
TOTALS	4	5	3	3	8	8	31

Source: CDC Reports

Table 9

Brucellosis in Packing Plant Employees

United States, 1958-1970

Year	Case Reports Received	Cases in Packing House Workers*	Percent of Total
1958	396	104	28
1959	658	155	24
1960	555	221	40
1961	413	174	42
1962	276	115	42
1963	257	122	47
1964	322	139	43
1965	226	101	45
1966	224	93	42
1967	209	108	52
1968	207	111	54
1969	195	139	71
1970	201	116	58
Total	4,139	1,698	41

*Includes government slaughter inspectors but not rendering plant workers.

Source: Case reports submitted to CDC.

TABLE 10

BRUCELLOSIS CASES IN PERSONS WITH UNKNOWN OCCUPATIONS OR OCCUPATIONS NOT RELATED TO THE LIVESTOCK AND MEAT PROCESSING INDUSTRIES, BY SOURCE OF INFECTION AND YEAR, UNITED STATES 1965-1974[11]

Year	Most Probable Source of Infection													
	Swine	Cattle	Swine or Cattle	Sheep or Goats	Unspecified Farm Animals	Dogs	Caribou or Moose	Feral Swine	Deer	Domestic Dairy Products	Foreign Dairy Products	Laboratory Accidents	Unknown	Total
1965	8	7	10	1				2	1	11	3	2	21	66
1966	8	13	8	3						13	10	2	35	92
1967	1	10	7				6			2	8	3	25	62
1968	7	7	2			1				13	16	9	20	75
1969	4	2	3							1	5	1	21	37
1970	1	2	7			1		2		3	9	7	33	65
1971	3	1	3					1		5	21	3	20	57
1972	1	4	1		1	1	1			2	10	4	18	43
1973	3	2		1		2	2			1	30	3	13	57
1974	3	4	4	1	1	1	3	2	1	6	13		27	66
Total	39	52	45	6	2	6	12	7	2	57	125	34	233	620
% of Total	6.3	8.4	7.2	1.0	0.3	1.0	1.9	1.1	0.3	9.2	20.2	5.5	37.6	100.0

TABLE 11

REPORTS OF HUMAN BRUCELLOSIS AND THE BOVINE BRUCELLOSIS CONTROL PROGRAM IN CALIFORNIA[70]

Year	Cases	Deaths	Program
1930-34	629	15	
1935-39	1038	13	
1940-44	1367	17	
1945-49	1124	14	1948 - Mandatory vaccination of dairy calves
1950-54	451	10	? Date - Pasteurization of Milk
1955-59	178	5	1957 - Test and slaughter initiated
1960-64	117	1	1962 - Became "modified certifed brucellosis area" BRT initiated for milk
1965-69	96	1	
1970-74	130	0	

Figure 1
HUMAN BRUCELLOSIS, UNITED STATES, 1947-1976[12]

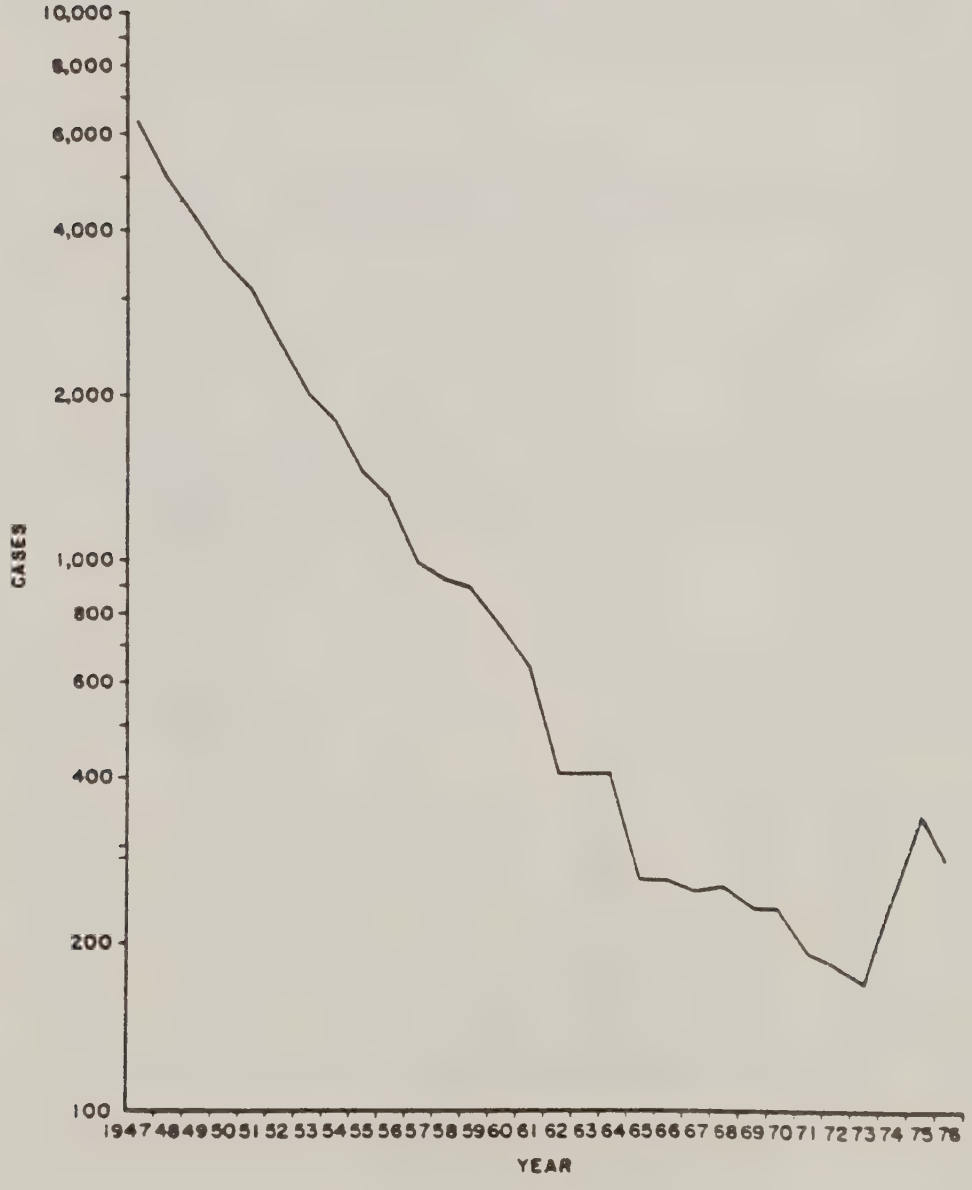


Figure 2

BRUCELLOSIS CASES IN MAN ACQUIRED FROM CATTLE, BY OCCUPATIONAL GROUP AND YEAR, UNITED STATES, 1965-1974[11]

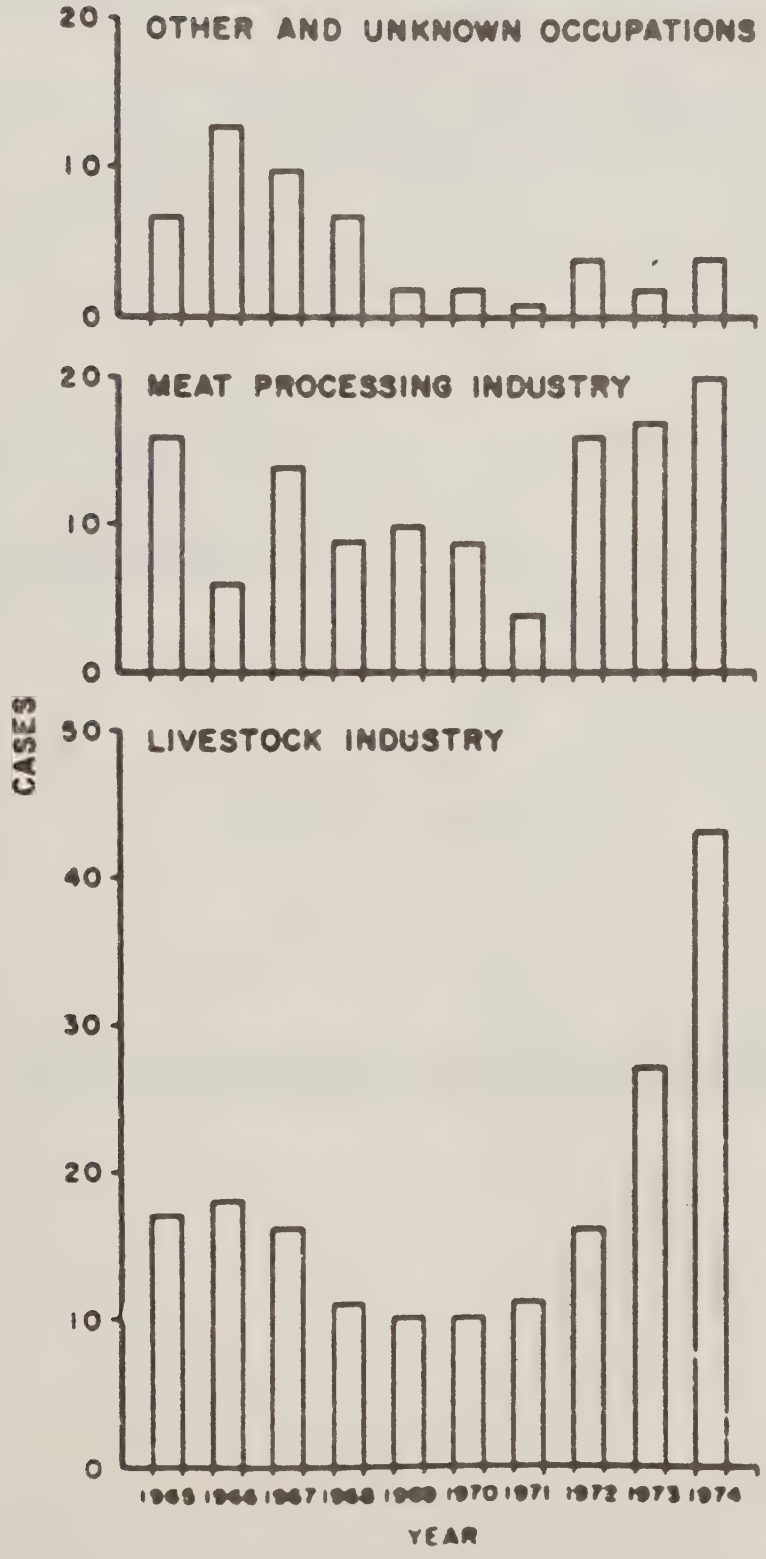


Figure 3

BRUCELLOSIS CASES IN ABATTOIR EMPLOYEES AND GOVERNMENT MEAT INSPECTORS, UNITED STATES, 1966 - 1976[11]

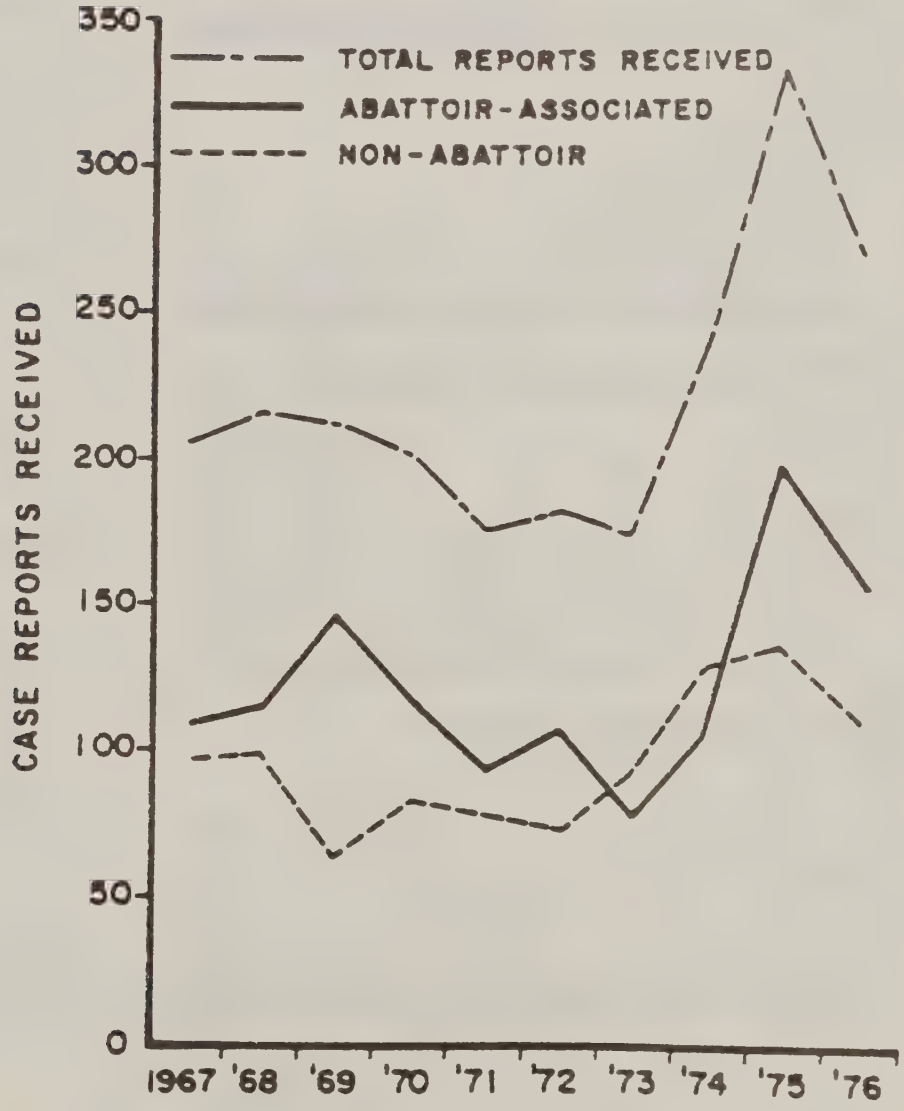


Figure 4 Number of cattle on farms, Minnesota, 1927–56.

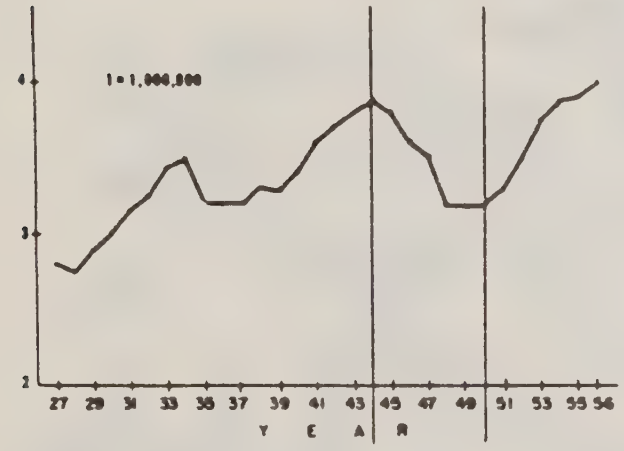


Figure 5 Reported number of human cases of brucellosis, Minnesota, 1927–56.

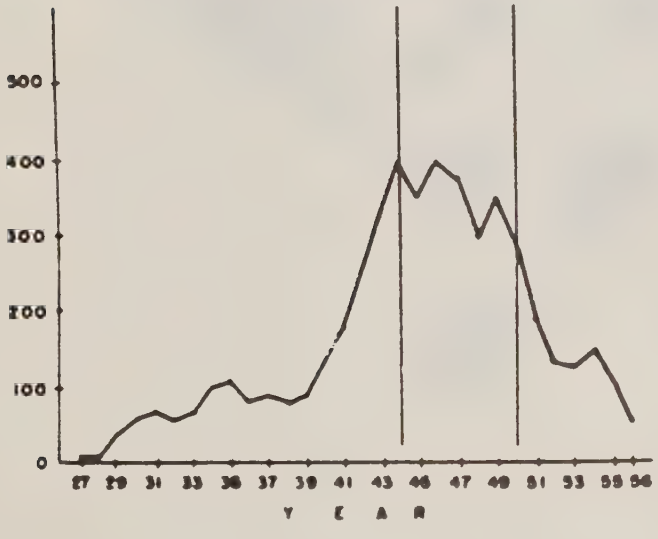


Figure 6 Number of Minnesota cattle reactors to brucellosis slaughtered, 1937–56.

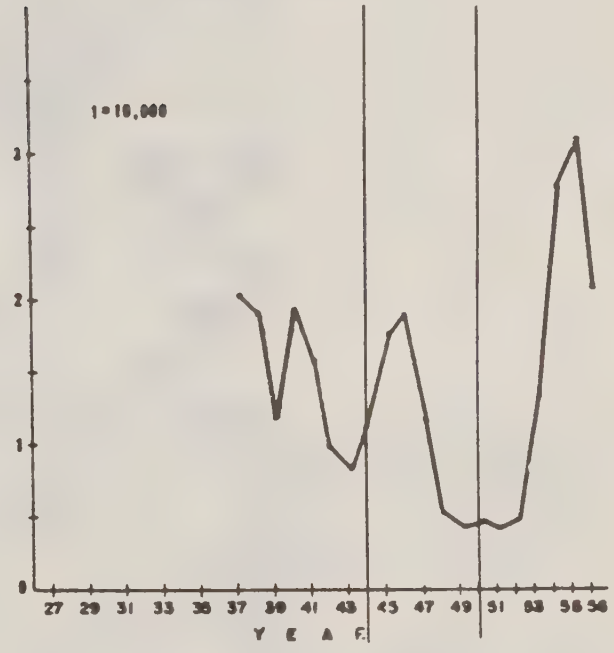
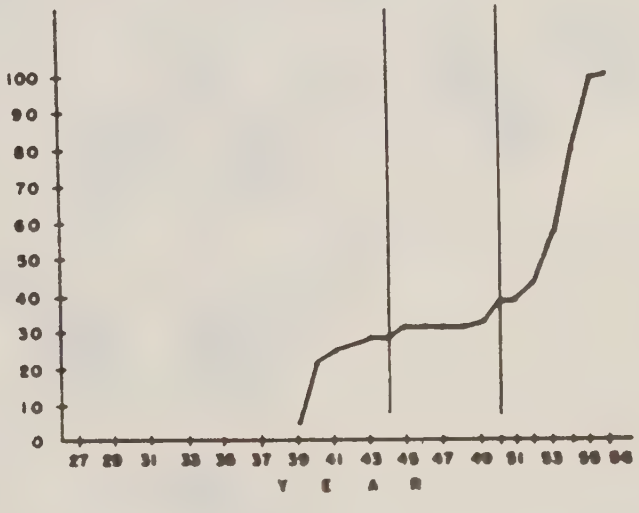


Figure 7 Percentage of counties under the area control program for brucellosis in cattle, Minnesota, 1939–56.



Reference 35

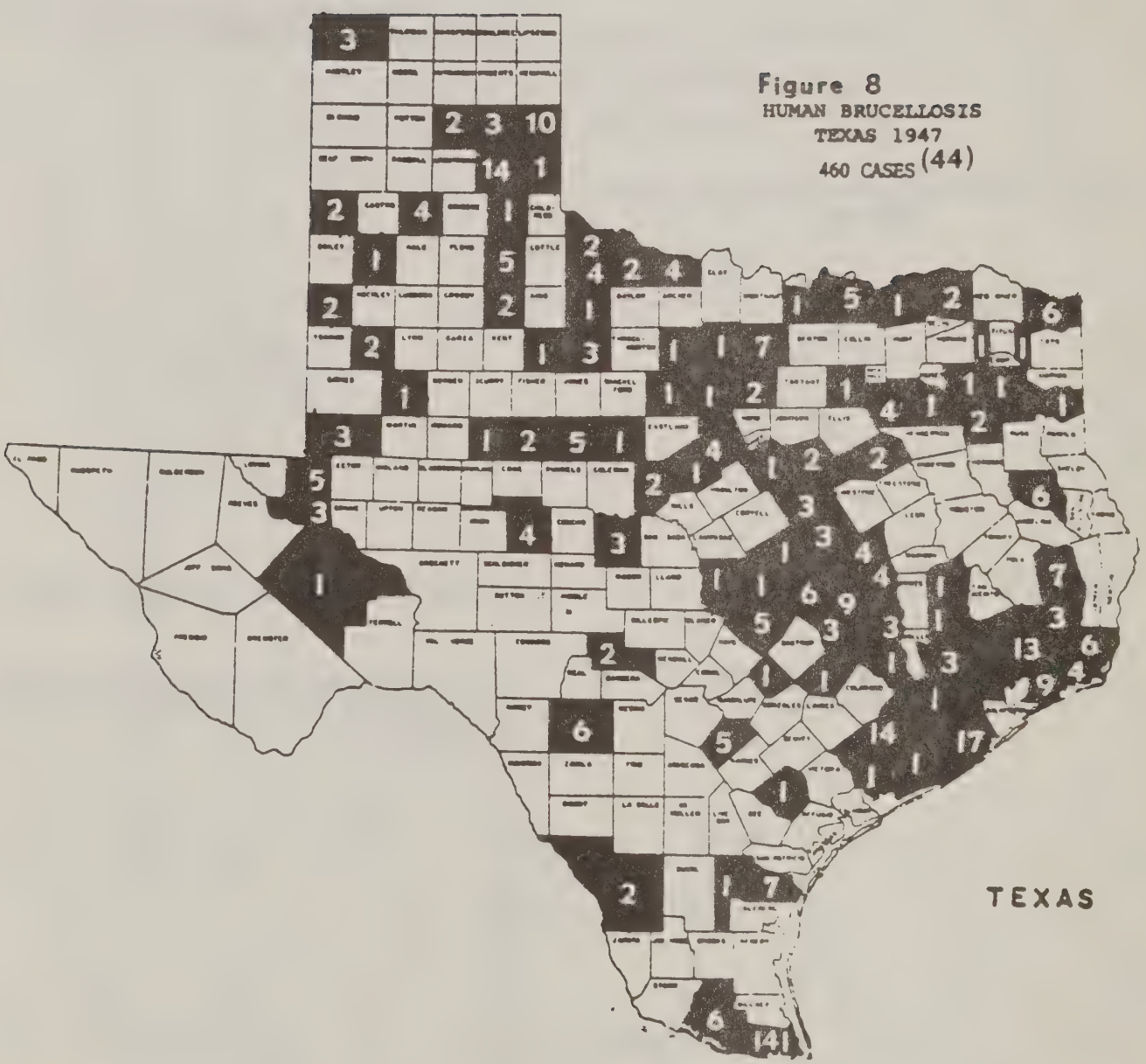


Figure 8
HUMAN BRUCELLOSIS
TEXAS 1947
460 CASES (44)

Figure 9
HUMAN BRUCELLOSIS
TEXAS 1970-1975
132 CASES(44)

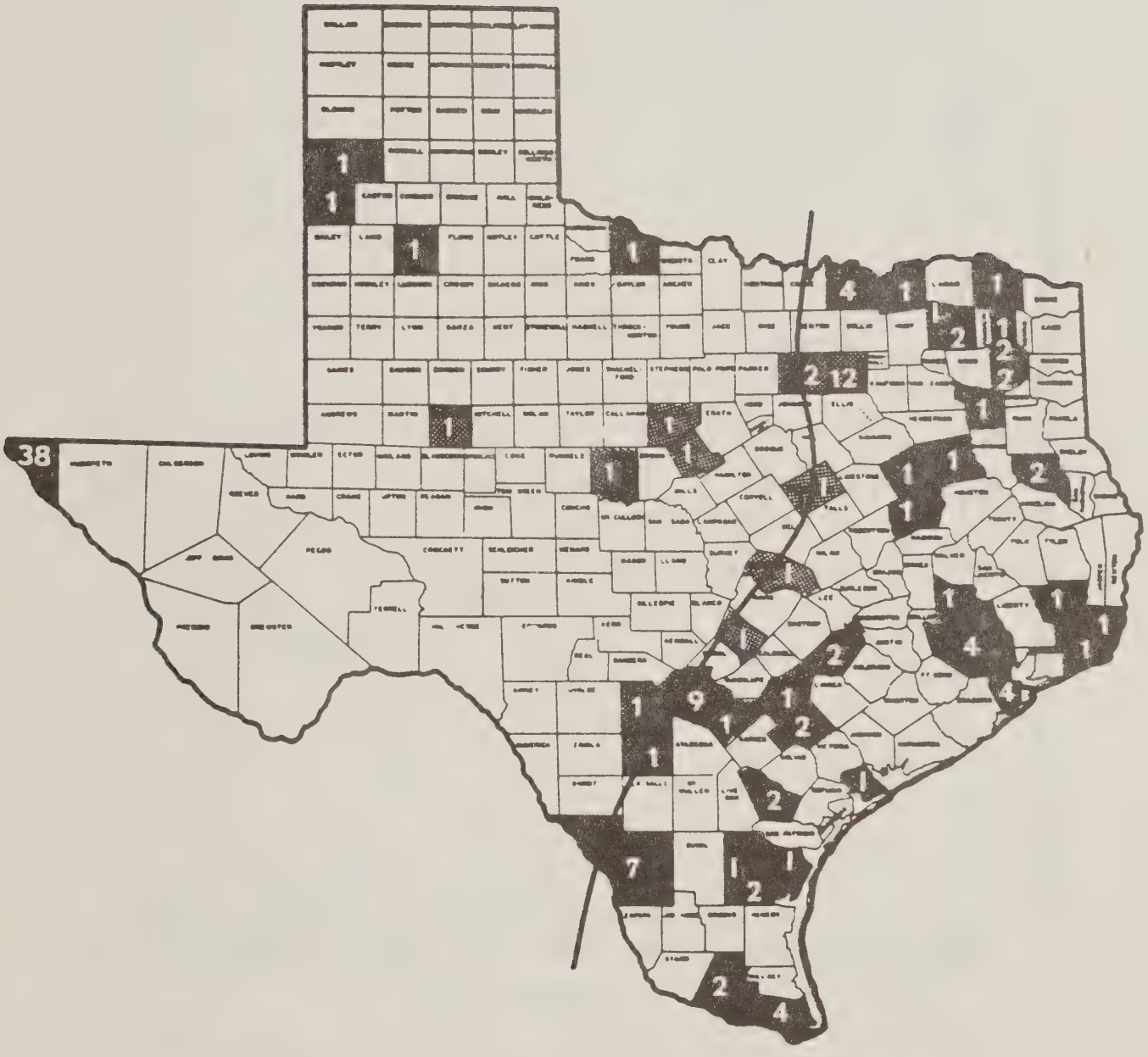
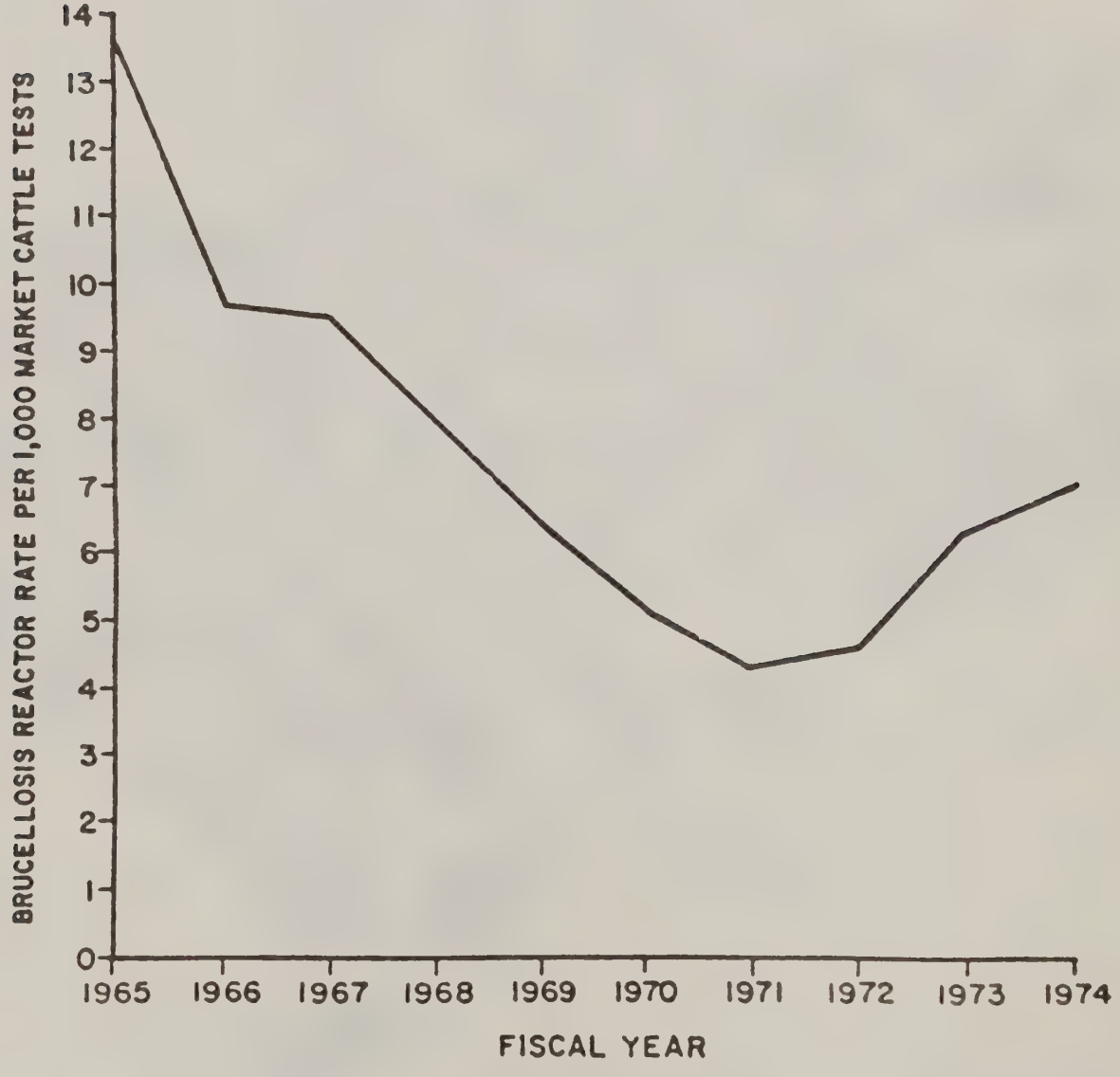


Figure 10

BOVINE BRUCELLOSIS REACTOR RATES FOUND IN MARKET CATTLE TESTING, UNITED STATES, FISCAL YEARS 1965 - 1974[77]



SOURCE: U.S. DEPARTMENT OF AGRICULTURE; COOPERATIVE STATE - FEDERAL BRUCELLOSIS ERADICATION PROGRAM STATISTICAL TABLES, FY 1965 - 1974

LABORATORY TESTS FOR DIAGNOSIS OF BRUCELLOSIS IN HUMANS

Question 9

				Tube Agglutination Tests				Significant Minimal Titer		Blood Cultures		
	Ser. Test Performed	Slide	Tube	Local Antigen	Commer. Antigen	Hrs. Time of Incub.	Temp.	With Symptoms	No Symptoms	Avail-able	Blood Clots	Whole Blood
Alabama	Unknown											
Alaska	Yes	x								Yes	x	x
Arizona	Yes		x		x	48	37°	1:160	4-fold changes	Yes		x
Arkansas	Yes	x	x		x	48	37°	1:160	1:160	Yes	x	x
California	Yes		x	x		½(cent.)	37°	4-fold	4-fold	Yes	x	x
Colorado	Yes	x	x		x	48	37°	1:20	1:80	No		
Connecticut	Yes		x		CDC	48	37°			Yes		x
Delaware	Yes		x		x	48	37.5°	1:200 - 1:300 or 4-fold rise		Yes		
Florida	Yes	x	CDC							Yes		x
Georgia	Yes		x	x		24	37°	1:40 2+ agg	1:160	Yes	x	x
Hawaii	Yes	x								Yes		x
Idaho	Yes	x	x		x	8	35°	1:80	1:80	No		
Illinois	Yes		x			24	37°	1:80	1:80	Yes	x	x
Iowa	Yes	x	x		NDL x	24	37°			Yes	x	x

LABORATORY TESTS FOR DIAGNOSIS OF BRUCELLOSIS IN HUMANS

Question 9

				Tube Agglutination Tests				Significant Minimal Titer		Blood Cultures		
	Ser. Test Performed	Slide	Tube	Local Antigen	Commer. Antigen	Hrs. Time of Incub.	Temp.	With Symptoms	No Symptoms	Avail-able	Blood Clots	Whole Blood
Kansas	Yes									Yes	x	
Kentucky	Yes	x	x		x	48	37°	1:80	1:80	Yes		x
Louisiana	Yes		x		x	48	35°	1:80	1:80	Yes	x	
Maine	No									Yes		x
Maryland	Yes		x	x		24	37°	1:160		Yes		x
Massachusetts	Yes		x		CDC x	48	35-37°	1:45		Yes	x	x
Michigan	Yes		x		x	18-20	37°	1:80	1:80	No		
Minnesota	Yes		x		USDA x	18	37°	Only test paired sera 2-fold rise in titer		Yes		x
Mississippi	Yes		x		x	48	37°	1:80	1:80	Yes	x	x
Missouri	Yes		x	x		48	37°			Yes	x	x
Montana	Yes		x	x		48	37°	4-fold rise	1:20 past inf.	Yes		x
Nebraska	Yes	x						1:80	1:80	No		
Nevada	Yes	x	x		x	48	37°	2+	2+	Yes		x

LABORATORY TESTS FOR DIAGNOSIS OF BRUCELLOSIS IN HUMANS

Question 9

				Tube Agglutination Tests				Significant Minimal Titer		Blood Cultures		
	Ser. Test Performed	Slide	Tube	Local Antigen	Commer. Antigen	Hrs. Time of Incub.	Temp.	With Symptoms	No Symptoms	Avail-able	Blood Clots	Whole Blood
New Hampshire	No									Yes	x	x
New Jersey	Yes		x		x	48	37°			No		
New Mexico	Yes	x								Yes	x	x
New York	Yes		x		USDA x	24	37°	1:80	1:80	Yes		x
North Carolina	Yes		x		x	48	37°	1:320	1:320	Yes		x
North Dakota	Yes	x	x		x	48	37°		1:80	Yes		x
Ohio	Yes		x		x	48	37°	1:160	1:160	No		
Oklahoma	Yes	x	x		x	48	37°	1:160	1:320	No		
Oregon	Yes		x		x	48	37°	1:80	?	Yes	x	x
Pennsylvania	No		Use	CDC in Atlanta						No		
Rhode Island	Yes	x	x		x	48	37°	1:80	1:80	Yes	x	x
South Carolina	Yes	x			x	48	37°	1:160	1:160	Yes		x
South Dakota	Yes	x	x		x	24	50°	1:160	1:320	Yes		x

LABORATORY TESTS FOR DIAGNOSIS OF BRUCELLOSIS IN HUMANS

Question 9

				Tube Agglutination Tests				Significant Minimal Titer		Blood Cultures		
	Ser. Test Performed	Slide	Tube	Local Antigen	Commer. Antigen	Hrs. Time of Incub.	Temp.	With Symptoms	No Symptoms	Avail-able	Blood Clots	Whole Blood
Tennessee	Yes		x	x		48	37°	1:40	1:40	Yes		x
Texas	Yes		x	x		48	37°	1:160	1:160	Yes	x	x
Utah	Yes		x		USDA x	48	37°	1:80	1:80	Yes		x
Vermont	Yes	x	x		USDA x					No		
Virginia	Yes	x	x		x	48	37°	1:160	1:160	Yes		x
Washington	Yes		x		x	48	37°	1:160	1:160	Yes	x	x
West Virginia	No									No		
Wisconsin	Yes		x		USDA x	48	37°	1:160	1:160	Yes	x	
Wyoming	Yes	x			x	2 min.		1:80	1:160	No		
Washington D.C.	Yes	x			x					Yes		
Puerto Rico	Yes		x		x	24	37.5°	1:80	1:80	Yes	x	
Virgin Islands	No									No		

XIII. RESULTS OF A QUESTIONNAIRE WHICH WAS SUBMITTED TO THE PUBLIC HEALTH EPIDEMIOLOGISTS OF ALL STATES IN THE UNITED STATES, DISTRICT OF COLUMBIA, PUERTO RICO, GUAM AND THE VIRGIN ISLANDS BY THE BRUCELLOSIS TECHNICAL COMMISSION

November 1977

Responses to the questionnaire were received from 52 of the 54 epidemiologists, a return rate of 96.3%. Only Indiana and Guam failed to respond in time for this report.

Note: In the following pages, the parenthetical references following the name of a state refers to the numbered comments made by the responder to each part of a question.

Question 1a: "Does your office receive reports of all cases of brucellosis infected herds of animals (dairy, beef, cattle, swine, sheep, goats, etc.) from the animal health officials and agencies of your state?"

Answered "yes" - 22 (42.3%)

Alabama[1], Arkansas[2], Colorado[3], Delaware, Florida[4], Georgia[5], Hawaii[6], Idaho[7], Maine[8], Michigan[9], Missouri[10], Montana[11], Oklahoma[12], Oregon[13], Pennsylvania[14], Texas[15], Utah[16], Vermont[17], Wyoming[18], Washington D.C.[19], Puerto Rico[20], Virgin Islands[21].

Answered "no" - 30 (57.7%)

Alaska[22], Arizona[22], California[23], Connecticut[24], Illinois[25], Iowa[26], Kansas[27], Kentucky[27], Louisiana[22], Maryland[22], Massachusetts[27], Minnesota[22], Mississippi[27], Nebraska[28], Nevada[29], New Hampshire[27], New Jersey[30], New Mexico[27], New York[27], North Carolina[27], North Dakota[22], Ohio[31], Rhode Island[27], South Carolina[22], South Dakota[32], Tennessee[27], Virginia[22], Washington[27].

Question 1b: "If answer is "yes", what use is made of the information by your office or other public health official?"

(1) Minimal use, dairies have just been recently identified on the quarantine report.

(2) Provides a starting point for epidemiological investigation, of human cases. The regular comprehensive investigation must still be made since all human cases are not traceable to known problem herds. Some result from new sources of infection.

(3) Epidemiologic investigations are conducted for cases confirmed in goats and dogs when reported. Significant bovine

and porcine outbreaks are investigated if human infection is considered possible.

(4) Brucellosis control in Florida in animals is under the jurisdiction of the Florida Department of Agriculture and Consumer Services. The information received is transmitted to county health units as a background for investigation of suspected human cases. The Health Program Office, Disease Control investigates any suspected or presumptive cases for determination of source.

(5) Each report is reviewed and analyzed for new infected areas. It is used for reference in talking with county or regional health officials as well as physicians when human cases are detected.

(6) Kept on file only.

(7) Correlated with human cases. Physicians are informed of areas of dairy and beef herd brucellosis.

(8) Maine has no positive herds. Should positive herds be detected, we would determine titers of the humans who work with the animals.

(9) The information is forwarded to local health departments for investigation.

(10) Public Health Nurses are asked to inquire about possible illness associated with infected animals.

(11) Alerts us to possible human exposure and cases.

(12) We receive information on cattle only.

(13) Surveillance and investigation.

(14) Reports are received from the Department of Agriculture but unfortunately, this is not done on a regular consistent basis. Those herds which appear to be more heavily infected or those which may have caused suspicious symptoms in human contacts are referred to us. This information is used by the Health Department for case findings.

(15) The Texas Animal Health Commission controls the quarantine requirements for livestock. Summaries of information relating to brucellosis infected herds are available for investigation of human disease.

(16) Passive surveillance is maintained by our office; active surveillance by the State Veterinarian. All animal and human disease investigations are coordinated between our office.

(17) We send letters to the affected farmers informing them of the hazards of brucellosis to humans.

(18) No use is made of the information.

(19) There are no herds of animals in D.C.; however, if such an incident occurs, the information would be helpful in detecting and investigating potential cases in humans.

(20) Kept in files. Inspect the herds that have any reactors so as to take proper action to prevent any human contact.

(21) An epidemiological investigation is made.

Question 1c: "If answer is "no", would this information be helpful to you in detecting and investigating potential cases of brucellosis in human?"

(22) No - 10 responses.

(23) Questionable.

(24) (-) The state has been free of bovine brucellosis for 12 years. All swine are now being tested.

(25) Based on studies conducted in Iowa, efforts to identify human cases of brucellosis by investigating contacts to infected animal herds proved unsuccessful when comparing cases identified to time spent.

(26) Previous studies indicate that human follow up of positive herds is of little values.

(27) Yes - 11 responses.

(28) Yes, but it would be very time consuming and we have a small staff.

(29) Don't know. Cost effectiveness, volumes of reports, no cases in humans (Note, Nevada does not require reporting of brucellosis in humans).

(30) There is no practical application of the information on a routine basis by this department. The information is available, however, if there is any reason to search for it.

(31) Obviously, any one in contact with these animals is a potential case, but we investigate those cases reported by the laboratory or local health departments.

(32) Possibly - 1 response.

Summary of Responses to Question 1:

Twenty two epidemiologists indicate that they receive reports of all infected herds of animals from animal health officials. The utilization of the information is variable. Some file it; some do nothing with it; some utilize it as a point of epidemiologic investigation; some inform the county and local health departments, public health nurses; some inform physicians in affected areas. One informs the farmers or owners of hazards of human brucellosis; one conducts investigations when goats and dogs are reported, and one would determine titers of people in contact with infected animals.

Thirty-two epidemiologists do not receive reports of infected herds of animals from animal health officials; however, 13 believed that the information would be of benefit. Fourteen indicated that the information would be of no benefit, two of whom stated that a previous study in Iowa revealed too little benefit when compared to cost. Two considered that the information would be of questionable value in their states.

Question 2a: "Do the public health officials of your state notify the animal health officials of all reported cases of human brucellosis?

Answered "yes" - 38 (73%)

Alabama(1), Alaska(2), Arizona(2), Arkansas(2), Connecticut(2), Delaware(2), Florida(2), Georgia(2), Hawaii(2), Idaho(2), Illinois(2), Kentucky(2), Maine(2), Maryland(2), Massachusetts(2), Michigan(2), Minnesota(2), Mississippi(1), Missouri(2), Montana(2), Nevada(3), New Jersey(2), North Dakota(2), Ohio(4), Oklahoma(2), Oregon(2), Pennsylvania(2), Rhode Island(2), Tennessee(2), Texas(2), Utah(2), Vermont(2), Virginia(2), Washington(1), Wyoming(1), Washington D.C.(2), Puerto Rico(2), Virgin Islands(2).

Answered "no" - 14 (27%)

California[5], Colorado[6], Iowa[7], Kansas[8], Louisiana[5], Nebraska[9], New Hampshire[8], New Mexico[8], New York[8], North Carolina[9], South Carolina[8], South Dakota[10], West Virginia[8], Wisconsin[9].

Question 2b: "If answer is "yes", what use is made of the information by the animal health official?"

(1) Unknown.

(2) An investigation is made to determine the animal source if the infected person had contact with animals.

(3) Brucellosis is not a reportable disease of humans in Nevada.

(4) Don't know what use is made. We check to see what the brucellosis status of the contact herd is or if it has been checked recently; this checking also applies to slaughter establishments.

Question 2c: "If answer is "no", would such reporting be beneficial to the program of public health?"

Yes - 10 responses

No - 3 responses

Possibly - 1 response

Comments:

(5) They are notified when it may be necessary during an investigation of a case. Many of our cases are associated with foreign travel which would be of no interest to the animal health officials. They are well aware of cases associated with slaughtering and livestock handling.

(6) Such notification will be initiated.

(7) More than 95% of our cases are packing plant associated where traceback is difficult if not impossible.

(8) Yes.

(9) No.

(10) Possibly.

Summary of Response to Question 2:

Thirty eight (73%) of the 52 epidemiologists notify the animal health officials of all reported cases of human brucellosis. Animal health officials use the information for the purpose of determining animal sources of the human disease. One has no cases to report because brucellosis is not a reportable disease in his state and 2 report that they do not know what use is made of the information.

Fourteen (27%) of the 52 epidemiologists do not report all cases to the animal health officials. Eight believe such notification would be beneficial, one possibly beneficial, and two believe that it would not be beneficial.

Question 3: "How many cases of human brucellosis were reported in your state in the calendar years 1970 through 1976? Show percentage abortus, suis, melitensis and number of deaths."

Responses to these questions were not revealing of any data very different from the received from the CDC. There is a large number of cases of human brucellosis in which the species of Brucella is unknown.

Question 4a: "What percentage of actual cases of brucellosis in humans do you estimate is reported by physicians or hospitals in your state?"

"Not a reportable disease in people." - Nevada

"Unknown" or no comment - 14

Alaska, Alabama, California, Connecticut, Louisiana, Maryland, Michigan, Mississippi, Nebraska, New Jersey, New York, Rhode Island, South Carolina, Puerto Rico.

0% - 2

Arizona, Virgin Islands

1%-9% - 2

Kentucky, Iowa

10%-19% - 2

New Hampshire, Oklahoma

20%-29% - 3

Maine, Missouri, Texas

30%-39% - 1

New Mexico

40%-49% - 1

Idaho

50%-59% - 8

Colorado, Georgia, Hawaii, Illinois, Kansas, Ohio, Oregon, South Dakota

60%-69% - 2

North Carolina, Wisconsin

70%-79% - 2

Pennsylvania, Utah

80%-89% - 3

Florida, Minnesota, Virginia

100% - 7

Arkansas, Massachusetts, North Dakota, Washington, West Virginia, Wyoming, Washington, D.C.

Question 4b: "What is the basis of your estimate? We will appreciate your best estimate keeping in mind physicians lack of familiarity with the disease, difficulty in diagnosis, failure to use laboratory procedures, the utilization of antibiotics without diagnosis, lack of reporting diagnosed cases, etc.

Responses to this question varied as follows: "Unknown", "we have no data", "no work has been done to identify subclinical cases or to determine misdiagnosed cases", "our knowledge depends

on the fact that all tests are performed in the state laboratory", "we have a high degree of physician awareness in our state", "pure guess", "well-established state-wide surveillance and reported system", "high percentage of negative samples in our laboratory", high physician awareness."

Summary of Responses to Questions 4a and 4b:

The results reveal a range of 0% to 100% with 13 people stating they have no idea of the percentage of human cases of brucellosis actually reported. The most popular figure of those who made an attempt to estimate is 50% and the distribution is otherwise about equal. It is surprising that seven epidemiologists state that 100% of cases are reported in their state.

Question 5a: Has your state adopted the provisions of the "Grade A Pasteurized Milk Ordinance - 1965 - Recommendations of the United States Public Health Service" with regard to Section 8, p. 88, "Administrative Procedure" as follows:

"All reactors disclosed on blood agglutination tests shall be separated immediately from the milking herd; the milk of these reactors shall not be used for human consumption?" Reactors are defined as cattle which are positive on an official serological test for brucellosis."

Answered "yes" - 48 (92.3%)

Alaska(1), Alabama(2), Arizona(1), Arkansas(1), California(1), Colorado(1), Connecticut(1), Florida(3), Georgia(1), Hawaii(4), Idaho(1), Illinois(1), Iowa(1), Kansas(5), Kentucky(6), Louisiana(1), Maine(1), Maryland(1), Massachusetts(7), Michigan(8), Mississippi(6), Missouri(1), Montana(1), Nebraska(9), Nevada(1), New Jersey(1), New Mexico(1), New York(10), North Carolina(1), North Dakota(1), Oklahoma(1), Oregon(1), Pennsylvania(1), Rhode Island(1), South Carolina(1), South Dakota(1), Tennessee(11), Texas(1), Utah(1), Vermont(12), Virginia(1), Washington(1), West Virginia(5), Wisconsin(1),

Wyoming[5], Washington D.C.[1], Puerto Rico[1], Virgin Islands[13].

Answered "no" - 4 (7.7%)

Delaware[14], Minnesota[15], New Hampshire, Ohio[16].

Question 5b: "What is current level of enforcement?"

(1) 100%.

(2) Not investigated by Division of Inspection or local health department and no follow up.

(3) To the best of our knowledge it is satisfactory.

(4) Probably only random sampling is done.

(5) Not known.

(6) Good.

(7) Enforced by State Food and Drug Division and Department of Agriculture.

(8) Must be slaughtered within 15 days. Ring testing four times per year. Milk samples collected from all producing herds. Blood collected at slaughter.

(9) Whenever infection is identified, individual is given 15 days to remove from herd by animals Industries. Dairy and Food requirement unknown.

(10) Greater than 90%.

(11) All dairy herds and all processing plants are under state inspector.

(12) High degree of enforcement.

(13) The Bureau of Environmental Health is responsible for the enforcement of the provision of the sale of pasteurized milk.

(14) Actually, not a part of USPHS ordinance - included in administrative procedures. Our regulation identical with USPHS model ordinance but does not include the paragraph on administrative procedures.

(15) Reactors must be slaughtered within 30 days under supervision of State Livestock Sanitary Board officials.

(16) Owners of cattle found positive for brucellosis on serological test are notified at once. If the animal is kept over 30 days, she is branded. She must go to slaughter within 90 days. This procedure is carried out by the Department of Agriculture.

Question 5c: "If the current level of enforcement is less than 100%, what problems have been encountered by those responsible for carrying out the provisions of the code?"

Response - No problems were listed except the following:
New York - Inadequate staff to exercise more extensive surveillance.

Question 5d: "Are those responsible for the enforcement of the milk ordinance notified promptly by the animal health officials when reactors are found in dairy herds?"

Answered "yes" - All except 3 below.

Answered "no" - Alabama, Ohio, and Puerto Rico.

Summary of Responses to Question 5 and its Subdivisions:

All epidemiologists respond that the provisions of the "Grade A Pasteurized Milk Ordinance of the USPHS model or its equivalent is in effect in their states, that enforcement is excellent, 100% in most states, that problems are not unsurmountable, and that communication is efficient.

Question 6a: "Does the law in your state prohibit commercial sale of raw unpasteurized milk?"

Answered "yes" - 33 (63.5%)

Alabama(1), Alaska, Colorado(2), Delaware, Florida, Hawaii, Illinois(3), Iowa(4), Kansas(5), Kentucky, Louisiana, Maryland, Massachusetts, Michigan(5), Minnesota(6), Mississippi, Nebraska(6), Nevada, New Hampshire(7), New Mexico(8), New York(9), North Carolina, North Dakota(10), Ohio(11), Rhode Island(12),

Tennessee, Virginia, West Virginia, Wisconsin[6], Wyoming, Washington D.C., Puerto Rico[13], Virgin Islands[14].

Answered "no" - 19 (36.5%)

Arizona[15], Arkansas[16], California[17], Connecticut[18], Georgia[18], Idaho[19], Maine[20], Missouri[21], Montana[22], New Jersey[23], Oklahoma[24], Oregon[25], Pennsylvania[26], South Carolina[27], South Dakota[28], Texas[29], Utah[30], Vermont[31], Washington[32].

Question 6b: "Please describe the circumstances and relative amounts of sale of raw unpasteurized milk in your state, e.g. farms, certified dairies, natural food outlets?"

(1) A small amount of raw milk is sold directly from dairy farms to the consumer. Some of this is from farm bulk tanks at Grade A dairies and a smaller amount is sold from ungraded dairies. One ungraded dairy makes home deliveries.

(2) In some instances raw unpasteurized milk is sold.

(3) Raw milk is sold at farm direct to consumer. Amount is practically nil.

(4) There is pressure to sell certified raw milk. There are two operations that sell raw milk in Iowa. People report to the dairy with their own containers, hence are not then in violation of the law.

(5) Some farmers may sell directly to close friends and neighbors.

(6) Raw milk may be sold under private agreement between the farmer and consumer. The consumer must come to the farm and bring his own containers.

(7) 2-4% of producer-distributor type sell illegal raw milk in restaurants and public institutions.

(8) A bill permitting the sale of raw milk at retail outlets passed the 1977 Legislature. Very little raw milk is being sold. Efforts are being made to repeal this bill.

(9) There is one certified dairy which sells raw milk.

(10) Any milk that is processed and bottled in North Dakota is pasteurized. The only unpasteurized milk which can be sold legally would be from a farmer to an individual and he would have to inform the individual that it is unpasteurized. A minimal amount is sold.

(11) Anyone who sold raw milk prior to November 1965 may continue to do so with permission of the health jurisdiction in which they are located. No new permits are issued.

(12) The sale of goats milk is exempt from Rhode Island Milk Sanitation Code. All nature food outlets are surveyed to enforce the prohibition of raw bovine milk.

(13) Just from unapproved sources as clandestine milk.

(14) Milk sold must be pasteurized according to law, however, private firms may offer raw milk for sale, but the animals must be inspected and approval must be secured.

(15) The sale of raw milk is governed under the same rules and regulations as the sale of pasteurized milk.

(16) A "grandfather" clause in the Arkansas Rules and Regulations pertaining to Grade A milk allowed six long-time producer-distributors of raw milk as of 1967 to continue. This number has been reduced to four. All four herds are tested quarterly by Ring Test and annually for t.b. Hereafter the annual blood test will include brucellosis. These are small herds numbering 12 to 40 animals and most of the output is distributed by route delivery.

(17) It is estimated that 0.5% of the milk sold in California is raw with about 95% of that originating from one large certified raw milk dairy. The State Legislature has mandated that raw milk shall be available.

(18) The raw milk must come from a state certified herd in the state. The amount of sales is estimated to be very small.

(19) 2% of milk is unpasteurized through 10 raw milk distributors.

(20) About 1% of all goats and cows milk sold in the state is raw, usually from farmers which are required to be licensed.

(21) Raw milk may only be sold directly from a producer-distributor farm. The amount sold is about 500 gallons per day.

(22) Of 305 Grade A dairies in Montana, 6 are certified retail raw. 236,635,962 lbs of milk are pasteurized and 2,070, 158 lbs are sold raw retail.

(23) Certified raw milk may be sold in New Jersey. There is none being produced in New Jersey. All shipments are from New York. About 50 gallons are sold daily in health food stores.

(24) No accurate information, but assumed to be an increaase due to "back to nature" trend.

(25) Farm and nature food outlets most likely.

(26) There are 100 producers licensed to sell unpasteurized milk in Pennsylvania. Strict control by the Department of Agriculture. 97 of the producers sell most of their milk to pasteurization processing plants and small quantities of raw milk are sold to local residents. Only one farm is known to package and sell most of its 300 gallons per day through natural food outlets. The remainder is sold to local people.

(27) There are two Grade A raw milk producer-distributors. One has less than 20 cows. The other is selling approximately 300 gallons per week.

(28) A milk producer may sell his own production of raw milk to a household consumer providing the contained is marked "raw milk".

(29) We have very little information relative to the sale of unpasteurized milk in Texas, however, to our knowledge, this is rare.

(30) 25 certified dairies sell raw milk in Utah. Milk must be sold on the premises.

(31) Mostly small amounts, farmer to farmer - intrafamilial on a licensed farm.

(32) Less than 1%.

Summary of Responses to Question 6:

It appears that all states have restrictions on the sale of raw milk. Some states do not allow any sale of raw milk, however, small amounts of raw milk are sold in many states from producer directly to consumer on the premises provided the consumer furnishes the containers. In some states the raw milk must come from certified dairies. In a few states "grandfather" clauses allow producers before a certain date to continue selling raw milk under an inspection system. The sale of goats milk is exempted from a requirement of pasteurization in one state. Illegal raw milk is sold in some states. Nature food outlets provide raw milk in many states.

Question 7: "Does your state allow sale of unpasteurized milk products (ice cream, cheese, butter, etc.) in nature food stores?"

Answered "yes" - 20 (38.5%)

Alabama[1], California, Connecticut[2], Georgia, Iowa[3], Maine, Maryland[3], Michigan[4], Minnesota[5], Montana[6], Nevada[4], New Hampshire[7], New Jersey[8], New Mexico, North Dakota, Oklahoma, Oregon[3], Pennsylvania[9], Texas, Vermont[3].

Answered "unknown" - 1 (2%)

West Virginia

Answered "no" - 31 (59.5%)

Alaska, Arizona, Arkansas[10], Colorado, Delaware, Florida, Hawaii, Idaho[11], Illinois, Kansas, Kentucky, Louisiana, Massachusetts, Mississippi, Missouri, Nebraska, New York, North Carolina, Ohio, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, Wasington, Wisconsin, Wyoming, Washington D.C., Puerto Rico, Virgin Islands.

Comments:

(1) And also curb markets.

(2) If from a certified herd in Connecticut.

(3) Only unpasteurized cheese.

(4) Only unpasteurized cheese if aged more than 60 days.

(5) Cheese if labeled "unpasteurized" and aged for 90 days.

(6) Under very strict regulations, (basically USPHS - FDA rules). Very little or none being sold currently.

(7) Must be licensed.

(8) Only cheese which has been aged 6 months or longer.

(9) The Pennsylvania Milk Law refers to the sale and control of raw milk only and makes no mention of products using or made from raw milk. According to the officials in the Division of Milk Sanitation, it is a silent area which has been somewhat ignored and remains to be tested.

(10) Except for four producers who sell only milk and ice cream.

(11) Two plants produced unpasteurized cheese.

Summary of Responses to Question 7:

Thirty one (59.5%) of the responders state that sales of unpasteurized milk products are not allowed to be sold through nature food stores (with the exception of Idaho). One epidemiologist had no information on this subject. Twenty (38.5%) responsed that their state allows sale of products made from raw milk to be sold through nature stores with various restrictions, most of which pertain to the aging of cheese. Pennsylvania has no regulations as yet in the law on this subject.

Question 8: "Does your state require serological tests before and during employment of employees of agricultural and agricultural processing enterprises with exposure potential?"

Answered "yes" - 1 (1.9%)

New Jersey(1)

Answered "unknown" - 1 (1.9%)

Alabama

Answered "no" - 50 (96.2%)

Alaska, Arizona, Arkansas, California(2), Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois(3), Iowa(4), Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina,

North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming, Washington D.C., Puerto Rico, Virgin Islands.

Comments:

(1) The American Medical Milk Commission tests employees monthly at processors with exposure potential.

(2) In one large swine slaughter house it is a requirement. This is the result of a study done at this plant several years ago because of the large numbers of human cases associated with the operation.

(3) While there are no state requirements several abattoirs independently require pre-employment and animal tests.

(4) Tests were required prior to 1967 but have not been required since 1967.

Summary of Responses to Question 8:

Only one state has a program of testing employees at processor for brucellosis. One responder had no information. 50 responders reported no program of testing except for a few slaughter houses which carry on independent surveys of employees.

Question 9a: "Is a serological test for brucellosis in humans performed in the public health laboratory of your state?"

Question 9b: "If answer is "yes", please indicate the type of agglutination test: Slide_____ Tube dilution _____"

Question 9c: "If tube agglutination test is used, describe:

Antigen prepared commercially or locally?

Time on incubation?

Minimal titer considered diagnostically significant:

(1) with symptoms

(2) without symptoms

Question 9d: "Is blood culture for Brucella available in the laboratory of your state?"

Question 9e: "If answer is "yes" are blood cultures performed:

(1) with blood clots?

(2) with whole blood?

Question 10: "Do the laws and regulations of your state provide that workmen's compensation may be awarded a person shown to have acquired brucellosis while being exposed in the work place?"

Answered "yes" - 37 (71.1%)

Arizona, Arkansas[1], California, Colorado, Florida[2], Georgia, Hawaii, Idaho, Illinois, Iowa, Kansas, Kentucky, Maine[3], Maryland, Massachusetts, Michigan, Mississippi[4], Missouri, Montana[5], Nebraska[6], Nevada[7], New Hampshire, New Jersey[8], New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee[9], Utah, Virginia, Wisconsin, Wyoming, Puerto Rico, Virgin Islands[10].

Answered "no" - 6 (11.5%)

Delaware, Louisiana[11], Minnesota, Texas, Vermont, Washington D.C.

Answered "unknown" - 5

Alabama, Rhode Island, South Dakota, Washington, West Virginia.

Omitted this question - 4

Alaska, Connecticut, New Mexico, North Carolina.

Comments:

(1) Farm workers are excluded from workman's compensation laws. Others such as packing house workers who contract brucellosis must have their compensation status determined on a case by case basis. Favorable rulings to the worker have been made when supporting evidence includes a physician's statement that brucellosis was contracted on the job.

(2) Florida Statutes, Chapter 440, "Occupational Diseases".

(3) But worker must be signed up for workman's compensation. Almost all full-time agricultural workers are signed up by law. The exceptions are (a) part-time or seasonal workers, (b) workers on a farm or in a concern with four or fewer full-time employees. The owners of such farms or establishments are not required to provide workman's compensation for their workers.

(4) Generally, the case has to go to the arbitration committee on appeal.

(5) Under Occupational Diseases Act of Montana, workman's compensation is paid if total disability at that job, for duration of disability. Limit on medical to $2,500.

(6) For state employees, we have compensation. Compensation for plant workers is up to management of the plant.

(7) Each case is considered on its own merit, and investigations.

(8) This is true for all infectious diseases.

(9) Worker must show cause for condition.

(10) If an individual can identify the case of brucellosis as being related to his occupation, the workman's compensation will grant the award to such a patient.

(11) There are no state laws to provide workman's compensation.

Summary of Responses to Question 10:

Thirty seven epidemiologists reported that their states provide workmen's compensation. Six reported that their states do not provide compensation for occupationally acquired brucellosis, and nine epidemiologists evidently did not have information of this subject.